ABET
Self-Study Report

for the

Aeronautical & Astronautical Engineering Program

at

University of Washington – Seattle

Seattle, Washington

June 27, 2019

CONFIDENTIAL

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for
EAC of ABET
Accreditation or Reaccreditation

BACKGROUND INFORMATION

A. Contact Information

Department Chair

Kristi A. Morgansen

William E. Boeing Department of Aeronautics and Astronautics

University of Washington, Box 352400

Seattle, WA 98195-2400

(206) 616-5950

morgansen@aa.washington.edu

Faculty ABET Coordinator (*Primary Pre-Visit Contact*)

James C. Hermanson

William E. Boeing Department of Aeronautics and Astronautics

University of Washington, Box 352400

Seattle, WA 98195-2250

(206) 616-2310

jherm@u.washington.edu

B. Program History

The program began in October 1929 with the founding of the Department of Aeronautical Engineering in the newly-built Guggenheim Hall. It was one of the eight such programs enabled by the Guggenheim Foundation for the Advancement of Aeronautics. In 1946 a Master's degree program was initiated, and 1959 saw the beginning of our PhD program. In 1962 the department's name was changed to Aeronautics & Astronautics, in recognition of the advancements being made in space exploration (the degree program's name was accordingly changed to Aeronautical & Astronautical Engineering). In November 2012, the department was named after William E. Boeing, founder of the Boeing Company, who through his generosity made possible the initiation of instruction in aeronautics at the University of Washington (UW) in 1917. Our program has been continuously accredited since 1936, and the last general ABET review took place in October, 2013.

Since the last ABET review in 2013 there have been a number of changes. Six additional faculty joined the department, three in the area of aerospace structures, two in controls, and one in fluids (that new position is research faculty). In addition, two existing members of the department were appointed as research faculty. During the same period there have been six faculty departures. These include two retirements (one each in the areas of structures and fluids), and three other faculty departures (two in controls and one in plasmas). In addition, the department chair Tony Waas (appointed in 2015) left the department in 2018. The department will have a total of 14 tenured or tenure-track faculty and two research faculty by the time of the ABET site visit in Autumn 2019.

The most substantial change to our undergraduate program has been the expansion and redefinition of the senior Capstone Design series. This program now includes both aviation- and space-related student capstone projects with substantial hands-on activity and product deliverables. In addition, all capstone projects receive industry funding and are actively conducted with industry interaction and review. More information on the Capstone Design series is provided under Criterion 4.

C. Options

The only options available within the undergraduate program relate to the student's choice of the senior capstone design course between the two that are offered: Airplane Design and Space Systems Design. Students select electives that best support the capstone design course of their choice. Current options outside of the undergraduate program are discussed below.

In 2016, the department added a 32 credit Minor in Aeronautics & Astronautics to support non-major STEM students considering multidisciplinary careers involving aerospace. The instruction focuses on preparing students in aerospace design, constraints, criteria, analysis and synthesis. The curriculum consists of engineering fundamentals (AA 210: Statics, CEE 220: Mechanics of Materials, ME 230: Dynamics and AA 260: Thermodynamics), A&A core courses (AA 310: Orbital & Space Flight Mechanics and A 311: Atmospheric Flight Mechanics) and 8 credits of AA prefixed electives.

Undergraduate students also have options for international study experiences at foreign institutions. Although not formally part of the Aeronautical & Astronautical Engineering curriculum, these programs allow for students to earn UW credits in addition to having the unique cultural experience of studying abroad. While there are many international opportunities available to UW students, the primary programs with which A&A is affiliated are:

Technical University of Berlin Summer Program: The program allows UW students to study a variety of engineering and science topics during the summer at the Technical University of Berlin. The TU Berlin Summer University program offers a range of specific technical courses relevant to aerospace, including satellite designing, energy efficiency, computer programming, and more. UW students in can participate in courses (conducted in English) between June and August ranging in duration from 2-12 weeks. The amount of credits roughly equal the number of weeks of the course, i.e., a 4-week course is roughly equivalent to 4 UW credits. Berlin cultural experiences, leadership training, and team-building activities are also included.

The College of Engineering GEA Aviation Summer Program: This program is hosted by GEA France, a consortium of leading French aeronautical engineering institutions. Lectures cover several key aeronautics topic including air transport, propulsion systems, structural analysis, and more. Lectures in aeronautics and space fundamentals in Toulouse are led by staff from ENAC (French Civil Aviation University) and ISAE-SUPAERO (Institut Supérieur de l'Aéronautique et de l'Espace). These are followed by lectures in Poitiers led by staff from ENSMA (École National Supérieure de Mécanique et d'Aérotechnique). The program includes site visits to airports and a field trip to the Paris Air Show. Students receive 9 UW credits of AA 498 for the program.

Australia Faculty-led Program: This program offers a field study of the North East Coast of Australia using ocean technology and traditional field techniques. Included are courses in Autonomous Systems and Robotic Biogeochemical Monitoring that allow for 6 UW quarter credits. Students develop skills for basic programming, robotics operations, aquatic chemistry sampling, and environmental data analysis/presentation. Students will apply these skills to independent research projects and experiments. In addition to in class research project, students participate in weekly Australia studies offered by faculty from the Queensland University of Technology.

A table showing recent UW student participation in these programs is provided below. Overall the three programs described above are doing well, though increasing the participation of A&A students in the TU Berlin and Australia program is a growth area. The department is considering ways in which this might be accomplished, such as by increased publicity and awareness of these opportunities among A&A students.

Table 1 UW Student International Program Participation Statistics

Program	2017		2018		2019	
	All	A&A	All	A&A	All	A&A
TU-Berlin Summer University Program	5	1	3	0	2	1
ENSMA/GEA Summer Program in France	4	4	0	0	7	7
Australia Faculty-Led Program	0 (not offered)	0	19	1	14	0

D. Program Delivery Modes

The Aeronautical & Astronautical Engineering program requires students to be enrolled full-time on-campus. Courses are offered during daytime hours for all four quarters of the academic year (but with only two lower-division courses during summer quarter). The program is of the traditional lecture / laboratory / recitation type.

E. Program Locations

The program is offered only at the University of Washington's Seattle Campus.

F. Public Disclosure

Information on the department's Program Education Objectives, student outcomes, undergraduate enrollment and graduation statistics, and other ABET accreditation information is provided at this url: https://www.aa.washington.edu/about/undergraduate-accreditation.

G. Deficiencies, Weaknesses or Concerns from Previous Evaluation(s) and the Actions Taken to Address Them

Two program Concerns were identified in the ABET Final Statement from the 2013 review:

1. *Criterion 2. Program Educational Objectives Criterion 2 requires that the program have published program educational objectives that are consistent with the mission of the institution and the needs of the program's various constituencies. Additionally, there must be a documented, systematically utilized, and effective process, involving program constituencies, for the periodic review of the program educational objectives that ensures they remain consistent with the institutional mission and the program's constituents' needs. The program lists its constituencies as students, faculty, industry, government agencies, and university graduate programs. Although most constituents have been involved as members of the external Visiting Committee, there is no evidence that students participated in the periodic review of the program educational objectives. Without participation on the part of all of the program constituents in reviewing the program educational objectives, there is the potential that future compliance with this criterion could be jeopardized.*

- *2013 Due-process response: The program did not provide a response to* *this shortcoming. The concern remains unresolved.*

2019 Response: For the last four years (minimum), graduating students have been asked via Senior Exit Survey to rank their self-assessment of preparedness on the Program Educational Objectives (PEOs). Since 2016, undergraduates have been specifically invited to meet directly with the Visiting Committee (biennially) in order to independently solicit and evaluate student input on the PEOs. And, since 2018, graduating students have been asked annually (Exit Survey) to indicate whether or not the PEOs meet their needs. Please see Criterion 2.E below.

2. *Criterion 4. Continuous improvement. Criterion 4 requires that the program regularly use appropriate, documented processes for assessing and evaluating the extent to which the student outcomes are being attained. The results of these evaluations must be systematically utilized as input for the continuous improvement of the program. Other available information may also be used to assist in the continuous improvement of the program. The program indicated that assessment of student outcomes (a) through (k) is conducted by guest faculty and students who review a final class presentation in the major design experience - AA 420/421, Spacecraft and Space Systems Design I/II. Since not all designs incorporated design, build, and test requirements, this means of assessment is not appropriate to assess outcome (b), the ability to design and conduct experiments, as well as to analyze and interpret data. Although outcome (b) is assessed in other courses, over-reliance on AA 420/421 to assess this student outcome could jeopardize future compliance with this criterion. Additionally, the program relies heavily on course assessments and other available information for program improvement. Without more inclusive consideration of student outcome evaluation results to improve the program, future compliance with this criterion may be jeopardized.*

- *2013 Due-process response: The program did not provide a response to this shortcoming. The concern remains unresolved.*

We identify two items in this concern:

(1) Lack of uniform requirements for design-build-test in senior capstone, resulting in a structural inability to assess certain student outcomes.

2019 Response: All senior capstone programs now require build/prototype and test/analyze requirements. Please see Criterion 4 below.

(2) Over reliance on voluntary, non-representative assessment tools such as course evaluations and informal consultation.

2019 Response: We have adopted a more robust assessment process and schedule that relies heavily on in-class performance for all students. This reduces the subjectivity and inclusivity concerns associated with data sources such as end-of-term course evaluations. Please see Criterion 4 below.

CRITERION 1. STUDENTS

A. Student Admissions

Student Admission Prior to Autumn 2018

There are three main pathways for students to apply to the UW Bachelor of Science in Aeronautical & Astronautical Engineering program including: 1) Direct Freshman Admission (high school seniors), 2) Early Admission (for UW students who just completed their first year) and 3) Upper Admission (for UW students who just completed their second year or transfer students from other institutions). The majority of students admitted to the program enter via the Upper Admission pathway.

Direct Freshman Admission: High school seniors are able to indicate Aeronautics & Astronautics major as their first choice major on their UW Freshman Application and be automatically considered to be admitted into the program. No other application would be required in order to be considered for Direct Freshman Admission into Aeronautics & Astronautics. The UW Office of Admissions reviews for admittance into the department based upon criteria created by A&A faculty. These criteria include GPA, standardized test scores (SAT/ACT), rigor of high school courses (with an emphasis in math, science and engineering courses), leadership skills and demonstrated interest in STEM as evidenced by participation in student clubs and/or community organizations. Direct Freshman Admission is designed for highly motivated students who know Aeronautics & Astronautics is the major for them. Students who are admitted to both the UW and to the department are coded as A&A majors in Autumn quarter of their first year. Students who are only admitted to the UW and not to the department are encouraged to apply via Early Admission and/or Upper Admission.

Early Admission: UW students who have just completed their first year at UW and have completed prerequisite courses required are eligible to apply to the program (indicated in Table 1.1). The annual deadline to apply via Early Admission is July 1. A minimum 2.0 in each prerequisite course and an overall 2.50 GPA of all prerequisite courses is also required. Other criteria that is utilized in the review process include rigor of coursework taken, grade trends throughout time, the personal statement where students are able to talk about their interest in Aeronautics & Astronautics, as well as any leadership, internship, work and research experiences. Early admission is designed for highly motivated UW students. Students who are admitted to the department are coded as A&A majors in Autumn quarter of their second year. Students who are not admitted to the department are encouraged to apply via Upper Admission.

Table 1.1 Early Admission Prerequisites

Mathematics (15 credits)	***Sciences (10 credits from below)***	***ENGL Composition (5)***
MATH 124, Calculus I (5)	CHEM 142, Chemistry I (5)	English Composition (5)
MATH 125, Calculus II (5)	PHYS 121, Mechanics & Lab (5)	
MATH 126, Calculus III (5)	PHYS 122, Electricity & Magnetism & Lab (5)	
	PHYS 123, Waves & Lab (5)	

Upper Admission: UW students and transfer students from other institutions who have just completed their second year and have completed prerequisite courses are eligible to apply to the program (indicated in Table 1.2). The annual deadline to apply via Upper Admission is July 1. A minimum 2.0 in each prerequisite course and an overall 2.50 GPA of all prerequisite courses is also required. Other criteria that is utilized in the review process include rigor of coursework taken, grade trends throughout time, the personal statement where students are able to talk about their interest in Aeronautics & Astronautics, as well as any leadership, internship, work and research experiences. Upper admission is designed as the typical pathway for students to enter the major. Students who are admitted to the department are coded as A&A majors in Autumn quarter of their third year.

Table 1.2 Upper Admission Prerequisites

Mathematics (24 credits)	***Sciences (20 credits) / ENGL Composition (5 credits)***	***Engineering Fund (20 credits)***
MATH 124, Calculus I (5)	CHEM 142, Chemistry I (5)	**AMATH 301, Scientific Computing (4)
MATH 125, Calculus II (5)	PHYS 121, Mechanics & Lab (5)	AA 210, Statics (4)
MATH 126, Calculus III (5)	PHYS 122, Electricity & Magnetism & Lab (5)	CEE 220, Mechanics of Materials (4)
MATH 307, Differential Equations (3)	PHYS 123, Waves & Lab (5)	ME 230, Dynamics (4)
MATH 308, Linear Analysis (3)	English Composition (5)	AA 260, Thermodynamics (4)
**MATH 324, Advanced Multivariable Calculus (3)		

* If students aren’t able to complete the prerequisites by the deadline, having up to 3 courses in progress (i.e., taken during Summer Quarter) is allowed.

**One of these two courses (MATH 324 or AMATH 301) may be taken in Autumn Quarter, if needed.

STARS Admission
The Washington State Academic RedShirt (STARS) Program was initiated beginning in autumn 2013 to support incoming engineering students from low-income, first-generation, and underserved backgrounds in navigating the transition to college-level engineering courses. The program is modelled after the "redshirt" year for athletes allowing students to devote much of their initial year to strengthening academic preparation and to building skills and support systems. The program accepts approximately 30 incoming freshmen per year. UW freshman applicants who meet program criteria are invited to apply. (STARS has since transitioned to a two-year program to ensure students maintain focus on their engineering prerequisites in the second year.)

Students who successfully complete all program requirements are placed into one of the 11 engineering majors. STARS program staff work with engineering program staff to implement the placement process. An average of 2 STARS students has placed into the Bachelor of Science in Aeronautical & Astronautical Engineering program over the past 4 years.

Enrollment of Students in A&A Core Courses
Since the Bachelor of Science in Aeronautical & Astronautical Engineering program is structured in a cohort based model, students are able to start taking A&A core courses once they have finished prerequisite courses required for Upper Admission. For Direct Freshman Admission and STARS participants, students start the A&A core courses two years after they have been officially been admitted. For Early Admission, students start the A&A core courses one year after they have been officially been admitted. For Upper Admission, students typically start A&A core courses immediately in the quarter they have been admitted. Students who are admitted into the program but do not complete prerequisite courses required for Upper Admission are dropped from the department.

Student Admission Beginning Autumn 2018

Beginning with the 2018 entering freshman class, the College of Engineering is transitioning to a Direct-to-College admission model as the normative pathway to engineering programs for students who enter the UW as freshmen. Under this model, there will be three pathways to gain admission to the Bachelor of Science in Aeronautical & Astronautical Engineering program.

Direct-to-College (DTC) Admission: The UW Admissions Office will use a holistic assessment process to select a cohort of freshman applicants to be admitted to the College of Engineering. Admitted students will enter the UW with Engineering Undeclared status. Engineering Undeclared students will be able to request placement into engineering programs after completion of freshman level requirements. Engineering Undeclared students who meet minimum requirements will be assured of the ability to enter an engineering program. However, due to capacity constraints, not all Engineering Undeclared students will place into their first-choice program. It is anticipated that 60-70% of the students admitted to the Bachelor of Science in Aeronautical & Astronautical Engineering program will come through this pathway.

Non-DTC Admission: Students who were not accepted through the DTC process may apply for admission through this competitive admission pathway which is available to serve students who discover their interest in engineering after being admitted to the UW as well as transfer students. This pathway is very similar to the Upper Admission pathway available prior to autumn 2018 that is described above. However, the application deadline has moved from July 1 to April 5. The revised deadline will allow for earlier notification to program applicants. It is anticipated that approximately 30-40% of the students admitted to the Bachelor of Science in Aeronautical & Astronautical Engineering program will come through this pathway.

STARS Program Admission: There are no changes to the STARS admission pathway.

Rationale for Change
In the fall of 2013, Dean Michael Bragg formed a committee consisting of College faculty and staff to provide recommendations for improving the student experience. Additionally, the Dean's Student Advisory Committee was formed then and was also asked to provide recommendations. Both groups identified a change in the admission process as the top priority.

Under the prior model, while a small number of entering freshmen were directly admitted to engineering programs, the majority of students followed a two-tiered process applying for program admission after two years of completing prerequisite courses. Beginning in 2008, the number of students pursuing engineering programs began to steadily increase and by 2013, demand greatly exceeded capacity. The resulting admission processes became highly competitive with many qualified students not being admitted to any engineering program. These students were then forced to identify alternative majors (or transfer to another institution) at a relatively late point in their academic career. The result was an environment where first- and second-year students felt high degrees of pressure and uncertainty, which compromised their overall student experience. Also, given the uncertainty as to which students would end up in engineering programs, it was difficult for the College to provide effective support and engagement for first- and second-year students. Indeed, a 2017 climate survey of Engineering students in majors and pre-engineers found that:

The 2017 Climate Survey also provided information about the engineering application process. Engineering majors were more likely to report fully understanding the engineering admissions process than pre-engineers (27% vs 14% fully understood).

Survey respondents qualitatively described the impact of the application process on their experience at UW. Pre-engineers were more likely to discuss the negative effects the application process had on them due to added stress. Some even discussed severe mental health challenges that they attributed to that additional stress. Pre-engineers also commented on the difficulty of being uncertain whether or not they would be admitted and the negative impact this had on their ability to plan for their future. Admitted majors commented on the additional stress of the application process, but were more likely to report no impact from the application process on their UW experience. Both pre-engineers and engineering majors discussed the effect the application process has on creating an overly competitive and uninviting atmosphere in the college.

In the fall of 2014, another faculty/staff committee was formed. The committee worked collaboratively with the Dean's Student Advisory Committee to develop a recommendation for a new structure for the College admission processes. The committees spent the majority of the year researching admission models and ended up exploring three options:

1. Make minor adjustments to the current system
2. Direct-to-major admission
3. Direct-to-college admission

After extensive input from a broad range of stakeholders, the recommendation was to move to a direct-to-college model. The DTC model will provide students with greater certainty that they will obtain an engineering degree. It will allow the College to structure a learning environment that provides a rich engineering experience over four years and it will provide students with the opportunity to explore the various engineering disciplines, allowing them to make an informed decision regarding their intended major.

B. Evaluating Student Performance

Evaluating student performance and progress is monitored on a quarterly basis after a student enters the program. Students must maintain an overall minimum cumulative grade point average of 2.00, a minimum quarterly grade point average of 2.00, and a minimum grade of 1.7 in any 300-level or 400-level program course required for the Aeronautical & Astronautical Engineering degree (two sophomore-level prerequisite program courses - AA 210, Statics, and AA 260, Thermodynamics - require minimum grades of 2.0). All other course requirements are subject to the University's minimum grade policy of 0.7.

Once they have been admitted to the program and start the A&A junior core courses, students are required to be registered for all the junior level courses offered each and every quarter. The program requirements are reviewed during the Department Orientation at the beginning of the junior year. Students must meet the prerequisite course requirements or they cannot register though the on-line registration system, which ensures that all courses that are required are completed each quarter. In order to ensure that any prerequisite grade requirements are met, the system checks the grade prerequisite requirements after pre-registration, but before the quarter begins, and will drop a student from the course for which he/she did not meet the minimum grade requirement. The student must then seek out the A&A Undergraduate Academic Adviser in order to petition for permission to register for the class or find out what alternatives are possible.

At the end of each quarter, the A&A Undergraduate Academic Adviser reviews students' grade reports to assure compliance with the department continuation policy. Students out of compliance with the program are placed on probation. Students on probation for two academic quarters are dropped from the program. Any student determined to be out of compliance with the continuation policy is required to meet with the department's Undergraduate Academic

Adviser, who creates an academic plan with the student. Any student requests for an exception to the department continuation policy must be made in writing and will be sent to the A&A Undergraduate Committee for faculty review.

C. Transfer Students and Transfer Courses

Although transfer student applicants from other institutions are reviewed via the Upper Admission pathway, they must also complete the UW Transfer Application. The annual deadline for the UW Transfer Application for Autumn quarter is February 15 (significantly earlier than April 5 deadline for the department). Prospective transfer students are highly encouraged to attend a UW Transfer Thursday information session hosted by the UW Office of Admission in order to understand the requirements of the university. They are also highly encouraged to meet individually with the A&A department undergraduate academic adviser to review their progress in applying to the department.

The vast majority of transfer credit comes from the WA state community and technical colleges with which the UW have articulation agreements. The UW Office of Admissions created and updates a course equivalency guide that helps students understand how their WA state community and technical college credits will transfer to the UW. The course equivalency guide is available at: https://admit.washington.edu/apply/transfer/equivalency-guide/.

For transfer credits from four-year institutions and outside of WA state, they are evaluated by the UW Office of Admissions after the student has been officially accepted to the UW. Students who believe their transfer credits were evaluated incorrectly by the UW Office of Admissions, may petition the A&A Undergraduate Committee to review their transfer courses. Courses residing outside of the A&A department, may be referred to the home department.

D. Advising and Career Guidance

The department has three full-time professional staff members in the academic & student services unit. The staff members include a Director of Academic Services who oversees all academic programs in the department, an Undergraduate Academic Adviser who works primarily with all undergraduate students in the department and a Graduate Academic Adviser who works primarily with all graduate students in the department.

The Undergraduate Academic Adviser's primary role is to serve as a resource while the student is in the department. The position also works with prospective students including high school students and their families, current UW students and transfer students from other institutions. Guidance in curriculum planning, possible areas of pursuit, and college success is provided. Information about different opportunities including student competitions & organizations, research, internships, careers and graduate school are also provided. During the department's new student orientation, all of the above areas are discussed.

The primary mode of communication from the A&A Undergraduate Academic Adviser is via the department's student e-mail lists. Students are required to check their UW email inbox regularly in order to keep up with different opportunities and changes they may occur during their studies. Typically about two weeks before quarterly course registration occurs, the A&A Undergraduate Academic Adviser sends an e-mail bulletin to all undergraduate students in the department notifying them that course registration is coming up. This e-mail bulletin contains information about the courses they must enroll in, reminders of how to enroll in research and internship credits as well as unique course opportunities.

Although advising is not mandatory, students are highly encouraged to make individual advising appointment or drop-in to further discuss details pertaining to their particular interests and situation. However, students are required to meet with the A&A Undergraduate Academic Adviser is when the student is on probation status as well as when they are ready to fill out their application to graduate from the program (typically two quarters before their intended graduation quarter). During a probation status advising appointment, a student's academic performance is discussed and what steps need to be taken (which may include a petition to the A&A Undergraduate Committee). During a graduation advising appointment, a student's degree audit is reviewed to talk about remaining courses that must be taken in order to graduate as well as their next steps after graduation (which may include career & graduate school opportunities).

The department also partners with the UW Career Center @ Engineering Office (CC@E) to provide career related services to our undergraduate students. This office is primarily served by three professional staff members (including a Director, Associate Director and Career Coach). One of the key services CC@E provides include individual coaching sessions where internship/career search process strategies, resume/cover letter reviews, mock interviews and salary negotiation strategies are discussed. The office also provides webinars/in-person workshops in the areas as well as host & support several career fairs on campus. CC@E also supports the use of Handshake, a UW database for students to find internships/jobs and for employers to post internships/jobs and find talent. CC@E and the department regularly collaborates to host A&A specific workshops and networking opportunities for our undergraduate students.

E. Work in Lieu of Courses

The UW awards credit for pre-college exams in Advanced Placement (AP), International Baccalaureate (IB), and A-Level/AS-Level exams. Students must contact the organization responsible for administering the exam to send scores to the UW in order to be processed. In some cases, credit may not be awarded but instead a placement into a particular course will be given. Specific UW policies and more information can be found at: https://admit.washington.edu/apply/transfer/exams-for-credit/.

The department encourages student participation in student design competitions. Students are able to earn A A 299 credit by participating in Design, Build, Fly (DBF) - an aircraft design competition or in the Society for Advanced Rocket Propulsion (SARP) - a rocket design competition. Each participating student is able to earn 1 credit of A A 299 per quarter. Grading is on a credit/no credit basis and does not count towards any particular major requirements.

The department also encourages student participation in undergraduate research that is overseen by department faculty. Students are able to earn A A 499 credit by participating in this opportunity. The student and faculty sponsor together discuss the project title & description of what research the student will be conducting. A research form is turned in with this information for processing by the A&A Undergraduate Academic Adviser. For every 3 hours/week that a student commits to during the quarter (or 30 hours in the quarter), the student is able to earn 1 credit of A A 499. Grading is on a credit/no credit basis and up to 6 credits of A A 499 & ENGR 321 may count towards the A&A technical elective requirement.

Many students participate in an internship while a student in the department. Students can earn internship credit (ENGR 321) via the UW Career Center @ Engineering office and are registered by the course administrator. All internships must be at least 50% engineering related and students must provide an offer letter in order to be registered for credit. Full-time work earns two credits in ENGR 321; part-time work earns one credit per quarter. Grading is on a credit/no credit basis and up to 6 credits of A A 499 & ENGR 321 may count towards the A&A technical elective requirement. In order to earn credit for the internship opportunity, there are four assignments students must complete: 1) a learning objectives assignment where students reflect upon different competencies they would like gain and/or improve upon, 2) an information interview with a professional at their internship site, 3) a final assessment where students identify their specific internship tasks and their accomplishments, and 4) an employer evaluation and student reflection.

F. Graduation Requirements

Students must complete a minimum of 180 credits in order to graduate with a Bachelor of Science in Aeronautical & Astronautical Engineering degree from the UW. Individuals must complete a minimum number of credits in the following areas: 1) Mathematics, Sciences and Engineering Fundamentals, 2) General Education Requirements, 3) A&A Core Courses, 4) A&A Capstone Design Courses, 5) A&A Technical Electives and 6) Free Electives.

Math, Science, Engineering Fundamentals (73 credits): Students are required to complete a year-long calculus sequence (MATH 124, 125, 126) as well as upper division level mathematics courses (MATH 307, 308, 324). In addition, students must complete one chemistry lab based course (CHEM 142) and a year of physics lab based courses (PHYS 121, 122, 123). To complete the science requirement, students must also take an additional 5 credits designated by the UW as Natural World (NW). Engineering fundamentals (A A 210, CEE 220, ME 230, A A 260, AMATH 301) must also be completed. These courses must be taken during the first two years as an undergraduate student.

General Education Requirements (29 credits): All UW students are required to complete a 5 credit English Composition before they graduate. 24 credits of Areas of Knowledge courses must also be completed, with a minimum of 10 in Visual, Literary & Performing Arts (VLPA) and a minimum of 10 credits in Individuals & Societies (I&S). In addition, a minimum of 3 credits of Diversity (DIV) must be taken in order to fulfill UW graduation requirements. These courses are typically taken during the first two years as an undergraduate student.

A&A Core Courses (50 credits): During the third year, A&A students complete a common set of sequence A&A core courses (300-level). Students must have completed math, science, and engineering fundamentals before starting the A&A Core Courses. The only exception to this policy is where the department allows MATH 324 or AMATH 301 to be taken concurrently during the first quarter of the third year.

A&A Capstone Design Courses (8 credits): During the fourth year, A&A students complete a two quarter capstone design. Students completing an aeronautics focused capstone, sign up for A A 410-411. Students completing an astronautics focused capstone, sign up for A A 420-421. Students must have completed the A&A core courses before starting the A&A capstone design program.

A&A Technical Electives (15 credits): Before graduating from the program, students must complete at least 15 credits of A&A technical electives (400-level). These are more narrowly focused courses then what is provided in the A&A core courses. The vast majority of A&A technical electives are 3 credits each. These courses are typically during the fourth year.

Free Electives (13 credits): Students must earn additional credit in order for their credit total to be at a minimum of 180 in order to meet university guidelines. Free electives are any courses that is not already counting towards any category of courses listed above.

Reviewing Progress

All students have access to their personal electronic degree audit where they can login and review their degree progress at any time. If a student has a concern about their degree audit or their progress, they should talk with the A&A Undergraduate Academic Adviser. All students are required to review their degree audit with the A&A Undergraduate Academic Adviser when they apply to graduate (about two quarters beforehand).

Course Deviations

If a student would like to request a course substitution, a request must be submitted in writing by completing the A&A course substitution form. For example, students may use this form when requesting to take a course that normally does not qualify for a particular requirement or when they would like to take a required a course at a different time than is typical. The A&A course substitution form is received by the A&A Undergraduate Academic Adviser and is routed to the A&A Undergraduate Committee for faculty review.

Table 1.3 Graduation requirements

A&A **Aeronautics and Astronautics Undergraduate Curriculum**
University of Washington
www.aa.washington.edu

Application & Enrollment Requirements for UW Non-DTC & Transfer Applicants
* Application Requirement (completed by **April 5** deadline)
+ Enrollment Requirement (completed before Autumn Qtr)
+& Enrollment Requirement (one course may be taken during Autumn Qtr)

Mathematics (24 Credits)
* Math 124 (5cr) – Calculus I
* Math 125 (5cr) – Calculus II
* Math 126 (5cr) – Calculus III
+ Math 307(3cr) – Differential Equations *[pr: Math 125]*
+ Math 308 (3cr) – Matrix Algebra *[pr: Math 126]*
+& Math 324 (3cr) – Multivariable Calculus *[pr: Math 126]*

Sciences (25 Credits)
*Chem 142 (5 cr) – General Chemistry with lab
Chem 152 (5 cr) – General Chemistry with lab
-or- other Natural World (NW course)
* Phys 121 (5cr) – Mechanics with lab *[pr: Math 124]*
* Phys 122 (5cr) – Electro/Oscillatory with lab *[pr: Math 125]*
+ Phys 123 (5cr) – Waves with lab *[pr: Math 126]*

Written & Oral Communications (5 Credits)
* English Comp (5cr) – English Composition
7 writing credits (W) are built into A&A courses.

Areas of Knowledge (24 credits)
10 credits of Visual, Literary & Performing Arts (VLPA)
10 credits of Individuals & Societies (I&S)
4 additional credits can be either VLPA or I&S
3 diversity credits (DIV) are required and can overlap with other areas of knowledge requirements.

Engineering Fundamentals (24 credits)
* A A 210 (4cr) – Engineering Statics *[pr: Math 126,Phys 121]*
+ CEE 220 (4cr) – Mechanics of Materials *[pr: A A 210]*
+ M E 230 (4cr) – Kinematics & Dynamics *[pr: A A 210]*
+ A A 260 (4cr) – Thermodynamics *[pr: Chem 142,Phys 121, Math 126]*
+& A MATH 301 (4cr) – Scientific Computing *[pr: Math 125]*

A&A Core Courses (50 Credits)
A A 301 (4cr) – Compressible Aerodynamics
A A 302 (4cr) – Incompressible Aerodynamics
A A 310 (4cr) – Orbital & Space Flight Mechanics
A A 311 (4cr) – Atmospheric Flight Mechanics
A A 312 (4cr) – Structural Vibrations
A A 320 (3cr) – Aerospace Instrumentation
A A 321 (3cr) – Aerospace Laboratory I
A A 322 (3cr) – Aerospace Laboratory II
A A 331 (4cr) – Aerospace Structures I
A A 332 (4cr) – Aerospace Structures II
A A 347 (4cr) – Control in Aerospace Systems
A A 395 (1cr) – Undergraduate Seminar
A A 460 (4cr) – Propulsion

A&A Capstone Design Courses (8 Credits)
Students must complete one of the two following options:
A A 410 (4cr) – Aircraft Design I
A A 411 (4cr) – Aircraft Design II
-or-
A A 420 (4cr) – Spacecraft and Space Systems Design I
A A 421 (4cr) – Spacecraft and Space Systems Design II

A&A Technical Electives (15 Credits)
Any 400-level A A prefixed course not used elsewhere in degree. See A&A website for exceptions to this policy.

Free Electives (13 Credits)
Additional coursework in any subject area not used elsewhere in degree.

Total Credits Required for Graduation (180 Credits)

G. Transcripts of Recent Graduates

We will provide transcripts from recent graduates to our Program Evaluator or to the ABET review team whenever requested.

CRITERION 2. PROGRAM EDUCATIONAL OBJECTIVES

A. Mission Statement

University of Washington
"The primary mission of the University of Washington is the preservation, advancement, and dissemination of knowledge. The University preserves knowledge through its libraries and collections, its courses, and the scholarship of its faculty. It advances new knowledge through many forms of research, inquiry and discussion; and disseminates it through the classroom and the laboratory, scholarly exchanges, creative practice, international education, and public service. As one of the nation's outstanding teaching and research institutions, the University is committed to maintaining an environment for objectivity and imaginative inquiry and for the original scholarship and research that ensure the production of new knowledge in the free exchange of facts, theories, and ideas.

To promote their capacity to make humane and informed decisions, the University fosters an environment in which its students can develop mature and independent judgment and an appreciation of the range and diversity of human achievement. The University cultivates in its students both critical thinking and the effective articulation of that thinking.

As an integral part of a large and diverse community, the University seeks broad representation of and encourages sustained participation in that community by its students, its faculty, and its staff. It serves both non-traditional and traditional students. Through its three-campus system and through educational outreach, evening degree, and distance learning, it extends educational opportunities to many who would not otherwise have access to them."

Available Online: http://www.washington.edu/admin/rules/policies/BRG/RP5.html

College of Engineering
"Our mission is to develop outstanding engineers and ideas that change the world."

Available Online: https://www.engr.washington.edu/about/mission

B. Program Educational Objectives

William E. Boeing Department of Aeronautics & Astronautics
"Educating successful engineers is one of the primary missions of the William E. Boeing Department of Aeronautics & Astronautics. Our undergraduate program educational objectives are informed by our departmental values as well as the mission statements of the University of Washington and of the College of Engineering.

We aim to prepare our graduates to be successful, highly valued engineers in industry, government organizations, and institutions of higher learning. Our further objective is to graduate engineers who thoughtfully serve the region, the nation, the profession, and society at large in three primary ways:

- Our graduates will be trained to solve critical technical problems related to aerospace engineering and devise innovative ways to develop and apply new technologies.
- Our graduates will be prepared to participate in identifying and responding to the problems facing society.
- Our graduates will be prepared to engage in a lifetime of continuous learning, leadership, and contribution to all areas of aerospace engineering practice.

To achieve these objectives, our faculty, staff, and teaching assistants pursue excellence in the department's educational programs relying on state-of-the-art computing, high-quality instructional facilities, and continuously improving methods in educational delivery and engagement."

Available Online: https://www.aa.washington.edu/about/undergraduate-accreditation
See Also, "Department Values": https://www.aa.washington.edu/about/values

C. Consistency of the Program Educational Objectives with the Mission of the Institution

Our program educational objectives are consistent with the mission statements of the University and the College of Engineering with respect to the preservation, advancement, and dissemination of knowledge. Our objectives enable our graduates to serve the state, the region, and the nation as first-rate engineers and leaders who are ready to make immediate positive contributions to society.

D. Program Constituencies

Students are the primary constituency of our educational program(s). Our PEOs serve the students by helping them prepare for long-term professional careers as well as continued formal education, preparing them to engage as citizens and leaders, and empowering them with tools for continuous learning in the face of a rapidly changing social, economic, and technological landscape.

Institutions of Higher Education are a constituency of our educational program(s). Our PEOs serve higher education by preparing graduate students who are skilled engineers, informed members of society, and life-long learners able to pursue advanced degrees and potential careers in academia.

Industry, which includes many parts of the private sector, is a constituency of our educational program(s). Our PEOs serve the private sector by preparing skilled engineers who can apply technical knowledge in the field of aerospace *and* apply aerospace technology in novel ways outside the aerospace industry. Our PEOs serve the private sector by preparing a workforce that is aware of and responsive to broader social contexts and prepared to continue learning and adapting as those contexts change.

Government Agencies & Research Labs are constituencies of our educational program(s). Our PEOs serve this sector by preparing skilled engineers who are able to apply aerospace knowledge and methods in a variety of public-sector settings such as basic research, mission operations, and safety. Our PEOs serve the public-sector by preparing a high-skill, specialized workforce that is prepared to operate in service of broader societal needs and to continue learning and adapting as those needs change.

E. Process for Review of the Program Educational Objectives

Our PEOs are reviewed by constituencies and other stakeholders on various timelines. The current text of our PEOs, for example, reflects updated context and other edits in order to communicate our goals as accurately and clearly as possible.

Faculty Review. The tenure-track and research faculty meet annually for long-term strategic planning and departmental review. At these retreats, the faculty (and appropriate members of the department staff) review departmental guiding documents, including PEOs and values statements. Based on the outcomes of that review, updates and revisions are considered and adopted as necessary.

Higher Education, Industry, and Public-Sector Review. Our department maintains a Visiting Committee with a robust membership that includes representatives from higher education, private industry, and the public sector. The Visiting Committee typically meets in-person on a two-year cycle. During this meeting, PEOs are presented for discussion and feedback is solicited as part of the Visiting Committee's summary report. Based on the recommendations of the Visiting Committee, updates and revisions to our PEOs are considered and adopted as needed.

Student Feedback. Students provide direct feedback to PEOs in two primary ways. First, members of the student body are invited to meet with the Visiting Committee during biennial Committee visits. The Committee is asked to solicit and comment on the students' feedback regarding PEOs in their summary report. Second, almost all graduating seniors complete an annual Senior Exit Survey which includes specific PEO question.

“How well do you feel you have been prepared in each of these objectives?”
[0 to 5, “Not at All” to “Very Well”]

	Average Self-Assessed Score			
	2016	**2017**	**2018**	**2019**
PEO 1	3.80	3.87	3.58	3.90
PEO 2	3.48	3.49	3.19	3.37
PEO 3	4.20	4.04	3.82	3.87

“These program objectives fully meet my needs.”
[Disagree, Somewhat Disagree, Neutral, Somewhat Agree, Agree]

	2016	**2017**	**2018**	**2019**
% Agree/Somewhat Agree	n/a	n/a	61%	75%

Based on these sources of student feedback, updates and revisions to our PEOs are considered and adopted as necessary.

CRITERION 3. STUDENT OUTCOMES

A. Student Outcomes

The Student Outcomes (SOs) describe the broad attributes, skills, and abilities that students should have upon graduating from our educational program. We have utilized ABET-provided student outcomes for the last several accreditation cycles.

Previous review cycles utilized an eleven-point list of SOs ("A-K"). Recently, ABET adopted a simplified seven-point list of SOs ("1-7"). We adopted this change as well as a consistent mapping of previous "A-K" outcomes onto the new "1-7" outcomes.

These outcomes are available on our department website:
https://www.aa.washington.edu/about/undergraduate-accreditation

Student Outcome (1-7)	**Formerly (A-K)**
1. ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	A, E
2. ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	C
3. ability to communicate effectively with a range of audiences	G
4. ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	F, H, J
5. ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	D
6. ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	B
7. ability to acquire and apply new knowledge as needed, using appropriate learning strategies	I

B. Relationship of Student Outcomes to Program Educational Objectives

A detailed discussion of our Program Educational Objectives (PEOs) is provided above (Criterion 2). However, the key points of our PEOs are:

1. Our graduates will be trained to solve critical technical problems related to aerospace engineering and devise innovative ways to develop and apply new technologies.

2. Our graduates will be prepared to participate in identifying and responding to the problems facing society.

3. Our graduates will be prepared to engage in a lifetime of continuous learning, leadership, and contribution to all areas of aerospace engineering practice.

We believe all SOs meaningfully contribute to all PEOs. However, we recognize that the direct relationship between certain PEOs and SOs may be stronger than others. The strongest connections between SOs and PEOs is represented below.

	STUDENT OUTCOMES						
	1	2	3	4	5	6	7
PEO 1	●	●	●		●	●	
PEO 2		●	●	●	●	●	
PEO 3		●	●	●	●		●

CRITERION 4. CONTINUOUS IMPROVEMENT

Starting with the 2015-2016 academic year, our department began a large-scale overhaul of student outcomes assessment. Many of our current assessment tools (and data collection) have been developed since then. We will focus on the assessments, data, evaluations, and improvements implemented in the last 3-4 academic years.

A. Student Outcomes

Assessment Cycle, Data Collection, & Evaluation Process

Students' progress and achievement in the seven stated Student Outcomes (SO) are assessed at multiple points during the two years a typical student will spend completing the BSAAE degree. These assessment points are specific metrics monitored at a programmatic level. The primary assessment tools and timelines for assessment are outlined in the table below.

YEAR 1	Autumn		Winter		Spring	
	395 Seminar	3 / Quarter	321 Lab Reports	~ Bi-weekly	322 Final Project	Annual
			321 Peer Evaluation (Mid)	Annual	322 Oral Presentation	Annual
			321 Peer Evaluation (Final)	Annual	322 Peer Evaluation (Mid)	Annual
					322 Peer Evaluation (Final)	Annual

YEAR 2	Autumn	Winter		Spring	
	(See Continuous Improvement, below)	Capstone SRR	Annual	Capstone CDR	Annual
		Capstone PDR	Annual	Capstone FDR	Annual
		Capstone Peer Evaluation (mid)	Annual	Capstone Final Rpt	Annual
				Capstone Peer Evaluation (final)	Annual
				Capstone Student Experience Survey	Annual
				Sr Exit Survey	Annual

Data for assessment points within a specific course are collected and stored electronically in the "Grades" portion of the Canvas site for each course. Canvas is a university-wide, third-party software centrally managed and supported by UW's information technology unit, IT Connect.

Student survey data (capstone experience survey, senior exit survey) are stored electronically in the online survey tools of Catalyst. Catalyst is another university-wide software that supports survey tools and is maintained by UW IT Connect. Survey tools are built by departmental student services staff in consultation with faculty leaders.

In addition to the specific assessment points discussed in this section, students participate in routine coursework and assessments including homework assignments, mid-term examinations, projects/reports, and final examinations. Student performance on coursework is monitored and assessed by instructors and teaching assistants to ensure all students are consistently progressing in their ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics (SO1) as well as acquire and apply new knowledge as needed, using appropriate learning strategies (SO7). Taking course grades as an indicator of assessment and attainment in these SOs, we expect 90% of students will graduate with an in-major GPA of 2.5 or higher

Assessment data are routinely evaluated by multiple individuals and groups within our department including:

- Department Chair
- Associate Chair for Academics
- Undergraduate Program Coordinator, “UPC” (Faculty)
- Undergraduate Committee (3-4 Tenure Track Faculty, Including UPC)
- Capstone Coordinator (Faculty)
- Course Instructors (320, 321, 322 in particular)
- Director of Academic Services (Staff)
- Undergraduate Academic Adviser (Staff)

Reponses to assessment evaluation are typically developed and implemented by a one or more of the individuals/groups above. Evaluation and responses occur as-needed depending on when information is received and the scope or urgency of the issue. Some matters (typically broad curricular questions) may be presented to the full faculty for consideration at a monthly meeting or annual retreat. A description of specific improvements made as a result of assessment evaluation is included below under “Continuous Improvement.”

Assessment Tools & Process

YEAR 1, AUTUMN

Assessment Tool:	**AA 395 Undergraduate Seminar**
Student Outcomes:	2, 3, 4
Expected Level of Attainment:	100% of students will complete all assignments on time

AA 395 is a required undergraduate seminar in which students attend weekly presentations on topics of professional practice, ethics, and emerging topics in aerospace engineering. Students must submit a written response (~750 words) to at least three (3) presentations. Completion of the assignment requires demonstrating in-depth engagement (comprehension, analysis, synthesis, etc.) and the ability to communicate about the topic in a manner accessible to multiple (including non-technical) audiences.

YEAR 1, WINTER

Assessment Tool:	**AA 321 Lab Reports**
Student Outcomes:	1, 6, 7
Expected Level of Attainment:	80% of students will earn 75%+ of the available points

AA 321 is a required, team-based aerospace experimentation course. Lab assignments focus on learning aerospace engineering concepts, practicing engineering methods for testing and analysis, and applying STEM principles to engineering problems. Students prepare and submit multiple lab reports in accordance with customary professional practice. Grade points are assigned for content and format to ensure students are acquiring new knowledge, practicing appropriate experimentation methods, applying appropriate foundational principles, and drawing appropriate conclusions.

Assessment Tool:	**AA 321 Lab Team Peer Evaluations (Mid & Final)**	
Student Outcomes:	4, 5	
Expected Level of Attainment:	90% students should earn	81 – 99 Points (Team of 4)
		54 – 66 Points (Team of 3)

Note: Attainment goal is for final peer eval only. Mid review is considered formative

AA 321 is a required team-based aerospace experimentation course. Lab assignments focus on learning aerospace engineering concepts, practicing engineering methods for testing and analysis, and applying STEM principles to engineering problems. Each student submits mid-quarter and end-of-quarter peer-evaluations describing their assessment of their teammates' effort, engagement, and contributions. Students distribute a total number of "peer points" to their teammates based on relative contributions. The total number of available "peer points" is based on the size of the team (30 points per team member, not including oneself). Ideally, all teammates would earn an equal number of available points.

YEAR 1, SPRING

Assessment Tool:	**AA 322 Team Project Reports (Written)**
Student Outcomes:	1, 2, 6, 7
Expected Level of Attainment:	80% of students will earn 75%+ of the available points

AA 322 is a required team-based project course. Students form teams of 3-4 students and are assigned an appropriate design-build-test project under the supervision of a faculty mentor.

Teams submit a final technical report. Grade points are assigned for content and format of the report to ensure students gain new knowledge, frame engineering solutions in a larger context, apply foundational principles, practice appropriate experimentation methods, conduct thorough analysis, draw appropriate conclusions, and effectively convey their results in written form.

Assessment Tool:	**AA 322 Team Project Presentation (Oral)**
Student Outcomes:	2, 3, 5
Expected Level of Attainment:	80% of students will earn 75%+ of the available points

AA 322 is a required team-based project course. Students form teams of 3-4 students and are assigned an appropriate design-build-test project under the supervision of a faculty mentor. Teams must provide a final oral presentation to classmates and faculty members. Grade points are assigned to ensure students verbally demonstrate their understanding, present material collaboratively as a team, and convey engineering problems/solutions to diverse audiences.

Assessment Tool:	**AA 322 Team Project Peer Evaluations (Mid & Final)**	
Student Outcomes:	4, 5	
Expected Level of Attainment:	90% students should earn	81 – 99 Points (Team of 4)
		54 – 66 Points (Team of 3)

Note: Attainment goal is for final peer eval only. Mid review is considered formative

AA 322 is a required team-based project course. Students form teams of 3-4 students and are assigned an appropriate design-build-test project under the supervision of a faculty mentor. Each student submits mid-quarter and end-of-quarter peer-evaluations describing their assessment of their teammates' effort, engagement, and contributions. Students distribute a total number of "peer points" to their teammates based on relative contributions. The total number of available "peer points" is based on the size of the team (30 points per team member, not including oneself). Ideally, all teammates would earn an equal number of available points.

YEAR 2, AUTUMN

Assessment Tool: **None**
Please See Continuous Improvement (below)

YEAR 2, WINTER

Assessment Tool:	**AA 410 & 420 Systems Requirement Review**
Student Outcomes:	2, 3, 4, 5, 6
Expected Level of Attainment:	80% of students will earn 80%+ of the available points

AA 410 / 420 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. In early winter, students prepare and present a Systems Requirement Review (or Design Requirement Review) to classmates, faculty, and industry reviewers. Grade points are assigned to ensure students understand and respond to initial specifications and requirements, present material collaboratively as a team, and convey engineering problems/solutions to diverse audiences (which includes contextualizing their findings for the audience).

Assessment Tool:	**AA 410 & 420 Preliminary Design Review**
Student Outcomes:	1, 2, 3, 4, 5, 6, 7
Expected Level of Attainment:	80% of students will earn 80%+ of the available points

AA 410 / 420 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. In late winter, students prepare and present a Preliminary Design Review (PDR) to classmates, faculty, and industry reviewers. Presentations include in-depth technical sessions with experts as well as open summary presentations to peers. Grade points are assigned to ensure students have developed an appropriately rigorous design-build-test-analyze plan within specifications, identified environmental and ethical considerations, present material collaboratively as a team, and convey engineering problems/solutions to diverse audiences.

Assessment Tool:	**AA 410 & 420 Team Peer Evaluations (Midway)**
Student Outcomes:	4, 5
Expected Level of Attainment:	90% students should earn 90%-110% of an equal share of "peer points," relative to team size i.e., [0.9*(100/(N-1))] < SCORE < [1.1*(100/(N-1))]

AA 410 / 420 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. In late winter, each student submits mid-project peer-evaluations describing their assessment of their teammates' effort, engagement, and contributions. Students distribute a total of 100 "peer points" to teammates (excluding themselves) based on relative contributions. Ideally, all teammates would earn an equal number of available points.

<u>YEAR 2, SPRING</u>

Assessment Tool:	**AA 411 & 421 Critical Design Review**
Student Outcomes:	1, 2, 3, 4, 5, 6, 7
Expected Level of Attainment:	80% of students will earn 80%+ of the available points

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. In mid spring, students prepare and present a Critical Design Review to classmates, faculty, and industry reviewers. Presentations include in-depth technical sessions with experts as well as open summary presentations to peers. Grade points are assigned to ensure students remained consistent with specifications, appropriately monitored project status/progress, continually assess environmental and ethical considerations, present material collaboratively as a team, and convey engineering problems/solutions to diverse audiences (which includes contextualizing their findings for the audience).

Assessment Tool:	**AA 411 & 421 Final Design Report**
Student Outcomes:	1, 2, 3, 4, 5, 6, 7
Expected Level of Attainment:	80% of students will earn 80%+ of the available points

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. In late spring, students prepare and present a Final Design Report (FDR) to classmates, faculty, and industry reviewers. Grade points are assigned based on demonstrated, overall performance in multiple key areas:

* Presentation & Communication
* Project/Team Organization
* Design Approach
* Prototyping & Testing
* Risk & Liability Assessment
* Ethical Considerations
* Impact on Society
* Codes & Standards

Assessment Tool:	**AA 411 & 421 Team Peer Evaluations (Final)**
Student Outcomes:	4, 5
Expected Level of Attainment:	90% students should earn 90%-110% of a proportional share of peer points, relative to team size [0.9*(100/(N-1))] < SCORE < [1.1*(100/(N-1))]

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. In late spring, each student submits final peer-evaluations describing their assessment of their teammates' effort, engagement, and contributions. Students distribute a total of 100 "peer points" to their teammates based on relative contributions. Ideally, all teammates would earn an equal number of available points.

Assessment Tool:	**Capstone Student Experience Survey**
Student Outcomes:	1, 2, 3, 4, 5, 6, 7
Expected Level of Attainment:	80% of respondents "Somewhat Agree" or "Strongly Agree" that Capstone had a positive impact on their Student Outcomes. (Goal: 60% response rate)

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. After the capstone program ends, all students are solicited to complete a “Capstone Experience Survey” asking them about their learning experience. In it, they are asked to rate their level of agreement with the statement “Capstone contributed to increasing my ability to… [SO1, SO2, SO3, SO4, SO5, SO6, SO7].”

Capstone Experience Survey Notes:

- 2016 response rate was <10%, Data Not Reported
- 2017 response rate was 29%
- 2018 survey suspended in favor of traditional course evaluations. Low response rates and lack of desired, in-depth data caused the department to reinstate survey for 2019.
- 2019 survey still in process

Assessment Tool:	**Senior Exit Survey**
Student Outcomes:	1, 2, 3, 4, 5, 6, 7
Expected Level of Attainment:	90% of respondents assess themselves as “Average,”, “Above Average”, or “Excellent” on each of the Student Outcomes. (Goal: 90% response rate)

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. After the capstone program ends, all students are solicited to complete a “Senior Exit Survey” asking them about their learning experience. In it, they are asked to assessment themselves (1-5, “Poor”-“Excellent”) on each of the seven SOs.

Assessment Results

In-Course Assessments	*Attainment Goal*	Student Outcomes	2016	2017	2018	2019
Average In-Major GPA at Graduation	*n/a*	1, 7	3.40	3.46	3.44	*In process*
% of Cohort with In-Major GPA of 2.5+	*90%*	1,7	100%	100%	100%	*In process*
395 Junior Seminar: Earn Full Credit, All Assignments	*100%*	2, 3, 4	*New Format in 2019*			98%
321 Lab Reports: Earn 75% of Total Points	*80%*	1, 6, 7	New in 2017	100%	96%	54%
321 Peer Evaluation: Earn 90-110% of Ideal Points	*90%*	4, 5	New in 2017	68%	78%	80%
322 Project Report (Written): Earn 75% of Total Points	*80%*	1, 2, 6, 7	New in 2017	90%	60%	79%
322 Oral Presentation: Earn 75% of Total Points	*80%*	2, 3, 5	New in 2017	70%	78%	79%
322 Peer Evaluation: Earn 90-110% of Ideal Points	*90%*	4, 5	New in 2017	79%	81%	85%
Capstone Sys Req Review: Earn 80% of Total Points	*80%*	2, 3, 4, 5, 6	96%	Data Missing	Incomplete Records**	100%
Capstone PDR: Earn 80% of Total Points	*80%*	1, 2, 3, 4, 5, 6, 7	74%		Incomplete Records**	100%
Capstone Peer Eval (Mid): Earn 90-110% of Ideal Points	*80%*	4, 5	*		*	*
Capstone CDR: Earn 80% of Total Points	*80%*	1, 2, 3, 4, 5, 6, 7	100%		Incomplete Records**	100%
Capstone Final Report: Earn 80% of Total Points	*80%*	1, 2, 3, 4, 5, 6, 7	100%		100%	95%
Capstone Peer Eval (Final): Earn 90-110% of Ideal Points	*90%*	4, 5	*		*	*

* Due to rubric changes over time in 410-411 and 420-421 Peer Evaluation scoring, historical data require cleaning and normalization in light of 2019 data. This assessment is currently in-process. Up-to-date data will be available at the 2019 site visit.

** See Continuous Improvement, below (p.40)

Survey Assessment: Capstone	***Attainment Goal***	**Student Outcomes**	**2016**	**2017**	**2018**	**2019**
Capstone Exp. Survey: Response Rate	*60%*	n/a	<10%	29%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	1	N too small	95%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	2		90%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	3		86%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	4		81%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	5		86%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	6		86%	n/a	*In process*
Capstone Exp. Survey: % Somewhat Agree/Strongly Agree	*80%*	7		81%	n/a	*In process*

Survey Assessment: Overall	***Attainment Goal***	**Student Outcomes**	**2016**	**2017**	**2018**	**2019**
Senior Exit Survey: Response Rate	*90%*	n/a	77%	96%	96%	92%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	1	100%	99%	96%	99%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	2	87%	93%	90%	93%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	3	98%	94%	92%	97%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	4	96%	91%	86%	90%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	5	96%	96%	96%	97%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	6	98%	97%	96%	96%
Senior Exit Survey: % Avg/Above Avg/Excellent	*90%*	7	98%	97%	96%	87%

B. Continuous Improvement

Additional Assessments for Continuous Improvement

In addition to the Student Outcomes assessments above, we conduct several other general assessments about our educational program. These include:

Tool	Respondents/Constituency	Frequency
Jr. Cohort Assessment	Undergraduates after one year in the A&A major	Annual
Sr. Cohort Assessment	Undergraduates shortly before graduating	Annual
Capstone Experience Survey	Undergraduates who completed the Senior Capstone Program	Annual
Capstone Industry Mentor Survey	Industry/Technical Mentors for Senior Capstone Teams	Annual
Sr. Exit Survey	Undergraduates shortly before graduating	Annual
Student Feedback Survey	Any UW Student	Continuous

Assessment Tool: **Junior Cohort Assessment**
Expected Level of Attainment: 90% Participation

Every spring, the Office for the Advancement of Engineering Teaching & Learning (ET&L) conducts an in-person focus-group assessment activity with the junior cohort. Students collectively identify and discuss aspects of the BSAAE curriculum, teaching, and overall student experience. ET&L staff then compile analyses and present summary reports to members of the department leadership.

Assessment Tool: **Senior Cohort Assessment**
Expected Level of Attainment: 75% Participation

Every spring, the Office for the Advancement of Engineering Teaching & Learning (ET&L) conducts an in-person focus-group assessment activity with the senior cohort. Students collectively identify and discuss aspects of the BSAAE curriculum, teaching, and overall student experience. ET&L staff then compile analyses and present summary reports to members of the department leadership.

Assessment Tool: **Capstone Student Experience Survey**
Expected Level of Attainment: 60% response rate

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. After the capstone program ends, all students are solicited to complete a “Capstone Experience Survey” asking them about their learning experience within their specific projects, within the overall capstone program, and how well the capstone program is integrated into the curriculum

Assessment Tool: **Capstone Industry Mentor Survey**
Expected Level of Attainment: 75% response rate

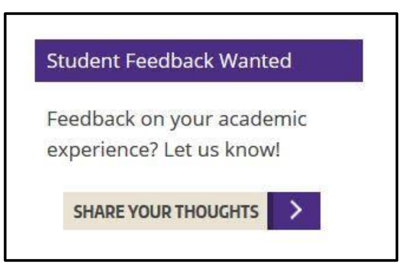
AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. After the capstone program ends, external technical mentors from industry sponsors are asked to complete a survey regarding their experiences with, observations of, and assessments of the industry-sponsored capstone projects.

Assessment Tool: **Senior Exit Survey**
Expected Level of Attainment: 90% response rate

AA 411 / 421 is a required aerospace capstone design course. Students work in teams to design, test, and analyze an original prototype based on client specifications. After the capstone program ends, all students are solicited to complete a “Senior Exit Survey” asking them about their learning experience. In it, they are asked to assessment themselves (1-5, “Poor”-“Excellent”) on each of the seven SOs.

Assessment Tool: **Student Feedback Survey**
Expected Level of Attainment: n/a

Our department maintains an on-going feedback mechanism (online survey) that allows students to provide feedback on any aspect of their learning experience with our department. This can include instructional experiences, facilities experiences, and comments or suggestions about curriculum. Students are routinely encouraged to provide detailed comments to the department at the end of each academic term (in addition to their written comments on course evaluation forms, which are delivered only to the course instructor). Submissions are received immediately by Student Services staff (who ensure student confidentiality) and then evaluated by the appropriate staff and faculty leaders for a response.



A link to the “Feedback Survey” is available on the right-hand side of any “students” page of our department website: https://www.aa.washington.edu/students/academics

Improvements Resulting from Assessment Evaluation

Multiple improvements have been implemented in recent years based on an evaluation of student outcomes and learning outcomes assessments.

JUNIOR YEAR (YEAR 1) IMPROVEMENTS

Improvement:	**321 Peer-Evaluation**
Student Outcomes:	4, 5
Implemented:	2016-17
Informed by:	Course Evaluations, Instructor Observation, Student Surveys & Cohort Assessments

Data indicated students were struggling to form and succeed as a team in AA 321. It was decided to reorganize the team creation and introduce peer-evaluations introduced to help students understand their roles within a team (SO5) and accept professional responsibilities (SO4) to ethically provide/accept meaningful feedback. Effective 2016-17, AA 321 student groups are assigned at random to help skills in collaboration and working in diverse groups and course requirements provide a clearly-stated expectation that each student should contribute equally to the effort. The effectiveness of this approach is assessed by a peer-evaluation process, where each group member anonymously provides feedback scores and comments on the contributions of their group members.

> *Intermediate Assessment:* In Winter 2017, peer evaluations were conducted only at the *end* of the academic term. Peer scoring indicated that students were assessing each other inconsistently and students did not have an opportunity to learn from feedback and adjust performance. After consulting with the Center for Advancement of Engineering Teaching & Learning (ET&L), a formative, mid-quarter peer evaluation was developed and introduced for use the following quarter (Spring 2017) in AA 322 as well as future offerings of AA 321.

Improvement:	**322 Project Implementation, Oral Presentations, Peer-Evaluations**
Student Outcomes:	1, 3, 4, 5, 6, 7
Implemented:	2012-13, 2017-18
Informed by:	Student Surveys & Cohort Assessments, Course Evaluations, Faculty Observation

Starting in 2013, the 322 laboratory class was changed from pre-scheduled experiments to independent group projects of 3-4 students. The change was driven by students' desire for more hands-on experiences (SO6) and a faculty-identified need to prepare students better for the self-guided team project they would encounter in Senior Capstone (SO5). Team projects also included the implementation of an oral presentation in order to develop and assess students' outcomes in communicating to multiple audiences (SO3).

Additionally, in 2016-2017, peer evaluations were added to better support and assess student outcomes in working as a team (SO5) and accepting professional responsibility for giving and receiving feedback ethically and effectively (SO4). (See 321 Updates, above)

> *Intermediate Assessment:* Between 2015 and 2017, it was identified based on student feedback, instructor observation, and industry experts (acting as project reviewers) that projects were often too broad and complex for junior-level students to complete in one-quarter. The faculty also identified unacceptable inconsistencies in the level of guidance and mentorship provided to the teams.

For 2017-18, a stricter advance review was implemented for all projects. The 322 instructor now collects early proposals from potential faculty mentors and reviews all projects (with the support of the Undergraduate Committee) for appropriate scope and complexity. Faculty mentors are more carefully solicited and selected to ensure appropriate advising to students. By 2018-19, far more students were fully completing their projects on time with a far more positive learning experience (less stress and anxiety) (SO1, SO7).

Improvement:	**395 Undergraduate Seminar Reorganized**
Student Outcomes:	2, 3, 4
Implemented:	2018-19
Informed by:	Faculty Observation, Student Surveys & Cohort Assessment

Students reported (and faculty agreed) that greater exposure to contemporary issues in professional practice and professional development was needed. This included topics such as resume preparation, job searches, professional ethics, and project management tools. In 2018-19 the syllabus for AA 395, "Undergraduate Seminar" was reorganized to focus on professional development. The course now includes a series of guest speakers who focus on a specific professional issue, lead discussion, and provide supporting materials. Students, in turn, must submit written responses to three topics demonstrating understanding and engagement. This is a new development and in-depth assessment evaluation has not yet been conducted.

Improvement:	**311 Realignment**
Student Outcomes:	1, 7
Implemented:	2018-19
Informed by:	Student Surveys & Cohort Assessment, Faculty Observation

Student feedback regarding AA 311, "Atmospheric Flight Mechanics" indicated that course material did not align with expectations – material focused too heavily on fundamental aerodynamics without offering the necessary introduction to air vehicle design and behaviors. Similarly, faculty in later courses reported students' struggling with 311 material (e.g., aircraft configuration) and requiring remediation. This resulted in significant inefficiencies as well as growing frustration for both constituencies. In 2018-19 a new course instructor, Prof. Antonino Ferrante, volunteered and (with the support of the department chair) significantly reformed the course syllabus to realign with agreed upon learning outcomes. Reports of student concerns have decreased. A full evaluation of the effectiveness of this improvement will be possible after students enter their senior curriculum (the point where remediation needs historically appeared).

Improvement: **312 Content Update & Integration with 447**
Student Outcomes: 1, 7
Implemented: 2017-18
Informed by: Faculty Observation, Student Surveys & Cohort Assessment

In 2016-17, it was identified that both students and faculty were concerned by the relative imbalance of topics in required coursework. Specifically, only one course focused on aerospace controls leading to an inability to address several advanced topics. Starting in 2017-18, AA 312, "Structural Vibrations" has been actively redesigned to incorporate introductory signal processing as preparation for AA 447, "Controls in Aerospace Systems." This allows students to enter 447 with more introductory knowledge and to proceed deeper in to control theory in 447. As of 2018-19, this effort included having 312 and 447 taught by the same instructor for consistency. Early instructor observation indicates positive change.

Improvement: **Move 447 to Junior Year**
Student Outcomes: 1, 7
Implemented: 2017-18
Informed by: Student Surveys & Cohort Assessments, Industry Feedback (formal & informal), Faculty Observation

In 2016-17, student feedback (primarily senior cohort assessments) and input from industry identified that aerospace control theory and applications were not available to students until the autumn of their final year. This resulted in a lack of preparedness for the growing influence of control topics found in industry internships (e.g., in the summer *before* senior year) as well as a very late exposure to control topics that could shape capstone choices/performance. Effective 2017-18, AA 447, "Control in Aerospace Systems" is now taught in the spring of Junior year. As of 2018-19, concerns about early exposure and internship readiness (regarding controls topics) have decreased.

SENIOR YEAR (YEAR 2) IMPROVEMENTS

Improvement: **A. All Capstone Teams Required to Build, Test, & Analyze**
B. Common Design Review Schedule Implemented
Student Outcomes: 6
Implemented: 2016-17

Informed by: 2013 ABET Review (Deficiency), Student Surveys & Assessments, Faculty Observation

Historically, senior capstone included two options – Aircraft Design (410-411) or Spacecraft & Space Systems Design (420-421). Aircraft design has a long history of hands-on designing, building, and testing of a working UAV. However, Space Design had gradually shifted to a conceptual space missions program with little-to-no vehicle design, prototyping, or testing. This impacted our ability to meaningfully use 420-421 to assess certain learning outcomes (specifically SO6, formerly outcome "b"). It also led to inconsistent educational experiences for students and inconsistent preparation for work in the spaceflight sector.

Effective 2016-17, the department partnered with the award-winning design-build student rocket club (SARP) to join our senior capstone program under the supervision of an expert faculty mentor. Now students in the 420-421 Space Design sequence gain experience designing, building, and test launching a rocket and payload as part of their capstone experience.

> *Intermediate Assessment:* Since this improvement was implemented, self-selected student enrollment in the Space Design capstone program has nearly doubled. Furthermore, students participating in Space Design capstone report a substantially higher job placement rate (senior exit survey) at graduation than any other capstone subgroup.
>
> *Future Improvements to Consider:* Though the SARP-Capstone partnership provides a successful synergy between student-led competitions and curricular requirements, the department has identified a need to ensure the educational requirements remain closely supervised by faculty members – especially since the SARP club can include 150+ students, many of whom are not BSAAE seniors participating in capstone. The department plans to continue refining the relationship between the student club and the department curriculum in order to serve the best interest of all constituents.

Currently <u>all senior capstone projects are required to include hands-on experience with building/prototyping as well as testing and analysis</u>. Furthermore, a <u>common schedule requiring specific design milestones (SRR, PRD, CDR, FDR) was established for more robust assessment of student outcomes at multiple points over time</u>. This **<u>resolved a deficiency identified in the 2013 ABET review</u>** and removed an unacceptable inequity in student experience. (Please also see "Industry-Sponsored Capstone" improvement below)

Improvement: Implement Industry-Sponsored Capstone
Student Outcomes: 1, 2, 3, 4, 5, 6, 7
Implemented: 2016-2017
Informed by: 2013 ABET Review (Deficiency), Student Surveys & Assessments, Faculty Observation, Industry Feedback

By 2014-15, multiple data sources indicated that areas for improvement in the capstone program included overwhelming team size, hands-on design experience, exposure to contemporary engineering problems in the aerospace industry, and preparation for working in a modern professional setting.

Starting in 2015-2016, the program established an option for students to participate in small-team, industry-sponsored capstone (ISC) programs. ISC projects have smaller teams (approx. 4-6), are assigned a project based on the industry sponsor's needs/specifications, and receive direct technical mentoring from a professional engineer. All teams were meant to have an industry mentor and a faculty mentor. To ensure assessment across all teams, a Senior Capstone Experience survey was implemented.

> *Intermediate Assessment:* Overall, the first year of ISC went well. However, at least one industry project resulted in a conceptual proposal (very limited design-build-testing) and student feedback indicated mentoring was inconsistent across teams.

In 2016-17 a more thorough vetting of potential projects was implemented to ensure all projects would include building and prototyping. A "mentor orientation" event was established in fall to ensure that all industry mentors were provided with consistent preparation and expectations.

> *Intermediate Assessment:* Better vetting of projects yielded a more consistent and rewarding student learning experience. However, 2017-18 student feedback indicated that the required combination of one industry + one faculty mentor produced inconsistent results. Some projects proceeded smoothly while other projects experience conflicting mentorship (lack of agreement/coordination) or minimal mentorship (lack of a primary mentor). 2017-18 also saw inconsistent data scoring and reporting of the project Design Reviews (SRR, PDR, and CDR), resulting in a heavier than usual reliance on Final Design Reports for student assessment.

In 2018-19 a dedicated instructor (Susan Murphy, Affiliate Professor) was selected to serve as a unifying program coordinator. The coordinator, with TA support, would provide programmatic oversight of student learning experiences and rigorous data collection/retention (rather than relying on individual faculty mentors) while individual industry mentors would focus on coaching students through an industry-like design and test experience. Early feedback indicated this method provided greater stability and efficiency. Full assessments are still in process.

> *Future Improvements to Consider:* Aerospace engineers need the ability to work as part of an integrated vehicle design team. Many of the small-team industry projects provide strong design experience but they can be highly focused on, for example, a specialized part. The faculty are considering a further refinement to the ISC option that requires small-team designs to include a minimum level of integration into a common air or space vehicle.

Improvement: **"Capstone Prep" / "Introduction to Integrated Design"**
Student Outcomes: 1, 2, 3, 4, 5, 7
Implemented: 2016-17, 2018-19, 2019-20

Informed by: Student Surveys & Cohort Assessment, Faculty Observation

Student preparedness for senior capstone has been a long-standing curricular concern. Students report inconsistent experiences and faculty report inconsistent readiness. Furthermore, as noted above, the program had minimal student assessment points/tools in the autumn of senior year. This left the department with limited data to understand where students were professionally and academically after returning from diverse summer experiences.

In 2016-17, the department established a required "Capstone Prep" course (autumn) that would provide a common experience for all students before they moved into capstone teams. Topics focused on project management and professional skills such a budgeting, purchasing, peer assessments, intellectual property, ethics, etc.

> *Intermediate Assessment:* Students were somewhat better prepared for organizational aspects of team capstone. However, students reported that the Capstone Prep was not substantive enough and that they did not consider it helpful for project readiness. Students and faculty continued to report inconsistent technical readiness for capstone.

In 2017-18, "Capstone Prep" was repeated with the addition of technical materials to provide a more robust learning experience that would provide professional development in project management *and* orient/refresh students on the specific tools and skills needed for capstone projects (e.g., CFD, FEA, vehicle configuration, etc.).

> *Intermediate Assessments:* Students survey and cohort assessment data clearly indicated (and faculty instructors agreed) that the course lacked sufficient organization and a unifying set of learning outcomes. However, faculty continue to report important shortcomings in student readiness, particularly in the integrative areas such as aircraft configuration.

In 2018-19, the autumn capstone prep course was suspended. Instead, a series of intensive technical lectures was incorporated into the first month of winter quarter, with each overall area (air or space) receiving a different lecture. A new instructor was identified for AA 311 with a specific goal of realigning that course with learning outcomes necessary for capstone readiness (see below). Finally, ten BSAAE students were allowed to join a new multi-university, small-team capstone program ("AerosPACE," sponsored by the Boeing Company). The AerosPACE program includes a set of preparatory autumn lectures with similar goals but different implementation compared with our earlier "Capstone Prep" course.

> *Intermediate Assessment:* The faculty who delivered winter lectures and the capstone program coordinator agree that the technical content of preparatory lectures remains necessary. However, using several weeks in winter quarter for intro lectures delayed project start times and detracted from students' early engagement with projects. Initial feedback from students and faculty involved with AerosPACE indicate that an autumn preparatory experience can provide a solution to both issues if well planned. The impact

on student readiness from improvements in 311 cannot be assessed until the juniors from 2018-19 begin senior capstone in 2019-20.

For 2019-20, the department plans to reintroduce an autumn preparatory experience, “Introduction to Integrated Design,” based heavily on the format (and some topics) used in the AerosPACE autumn experience. The 2018-19 Capstone Coordinator has been retained for summer 2019 to develop a schedule and set of topics for autumn 2019. Part of the autumn experience will include student outcomes assessment data collection at the beginning of Year 2 – which is currently missing from our assessment cycle.

CRITERION 5. CURRICULUM

A. Program Curriculum

5.A.1 Program Curriculum

The program curriculum is presented in Tables 5.1.1–5.1.4 on the following pages. For the convenience of the reader, each year of the curriculum is shown in a separate table.

5.A.2 Alignment of Curriculum with Program Educational Objectives

The curriculum aligns with the program education objectives through the structure of the prerequisites and the core curriculum of the major, culminating in the capstone design sequences in the senior year. The sequences of courses required for the aeronautics and astronautics major build upon each other from the beginning of the freshman year, students are introduced to problem-solving issues throughout the curriculum, and are encouraged to think creatively. Some courses, particularly the capstone design courses, involve team projects that focus on solving specific and more general design problems. This structure prepares the students to solve critical technical problems related to aerospace engineering, to devise innovative ways to develop and apply new technologies, and to participate in the identification and solution of problems facing society.

The curriculum is broad-based and covers many areas. The undergraduate degree encourages students to reach beyond what they have learned in the classroom. The capstone design courses frequently feature guest lecturers who present real-world problems that industry is facing, and discuss how these issues can be considered. The program also encourages students to be involved in undergraduate research activities that they can then apply toward their AA technical electives. This allows students to discover more about particular discipline areas and their relationship to the world at large. It also and influences their choices for continuous learning. In other words, the curriculum and research experience opens the eyes of students to see what lies beyond the classroom and to independently seek out more information, thus laying the foundation for lifelong learning.

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Table 5.1.1 Year 1

		Subject Area (Credit Hours)					
Course (Department Number Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required Elective or a Selected Elective by an R an E or and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design (√)	General Education	Other	Last Two Terms the Course was Offered: Year and Semester or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
Autumn Quarter							
MATH 124 Calculus I	R	5				W 19, Sp 19	Various
CHEM 142 General Chemistry & Lab	R	5				W 19, Sp 19	Various
ENGL 131 English Composition (or equivalent)	R			5		W 19, Sp 19	Various
Winter Quarter							
MATH 125 Calculus II	R	5				W 19, Sp 19	Various
General Education – Natural World	SE	5				W 19, Sp 19	Various
General Education - VLPA or I & S	SE			5		W 19, Sp 19	Various
Spring Quarter							
MATH 126 Calculus III	R	5				W 19, Sp 19	Various
PHYS 121 Mechanics & Lab	R	5				W 19, Sp 19	Various
General Education - VLPA or I & S	SE			5		W 19, Sp 19	Various

Table 5.1.2 Year 2

		Subject Area (Credit Hours)					
Course (Department Number Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required Elective or a Selected Elective by an R an E or and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design (√)	General education	Other	Last Two Terms the Course was Offered: Year and Semester or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
Autumn Quarter							
MATH 307 Differential Equations	R	3				W 19, Sp 19	Various
PHYS 122 Electromagnetic & Lab	R	5				W 19, Sp 19	Various
A A 210 Statics	R		4			W 19, Sp 19	207
VLPA or I & S	SE			2		W 19, Sp 19	Various
Winter Quarter							
MATH 308 Matrix Algebra	R	3				W 19, Sp 19	Various
PHYS 123 Waves & Lab	R	5				W 19, Sp 19	Various
M E 230 Kinematics & Dynamics	R		4			W 19, Sp 19	Various
VLPA or I & S	SE			4		W 19, Sp 19	Various
Spring Quarter							
A A 260 Thermodynamics	R		4			Su 18, Sp 19	132
CEE 220 Mechanics Of Materials	R		4			W 19, Sp 19	Various
MATH 324 Advanced Multivariable Calculus	R	3				W 19, Sp 19	Various
VLPA or I & S and DIV	SE			3		W 19, Sp 19	Various

Table 5.1.3 Year 3

		Subject Area (Credit Hours)					
Course (Department Number Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required Elective or a Selected Elective by an R an E or and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design (√)	General education	Other	Last Two Terms the Course was Offered: Year and Semester or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
Autumn Quarter							
A A 310 Orbital & Space Flight Mechanics	R		4			Au 17, Au 18	89
A A 311 Atmospheric Flight Mechanics	R		4			Au 17, Au 18	84
A A 320 Aerospace Instrumentation	R		3			Au 17, Au 18	74
A A 395 Undergraduate Seminar	R		1			Au 17, Au 18	88
A MATH 301 Beginning Scientific Computing	R		4			W 19, Sp 19	Various
Winter Quarter							
A A 302 Incompressible Aerodynamics	R		4✓			W 18, W 19	80
A A 312 Structural Vibrations	R		4			W 18, W 19	78
A A 321 Aerospace Laboratory I	R		3			W 18, W 19	74
A A 331 Aerospace Structures I	R		4			W 18, W 19	81
Spring Quarter							
A A 301 Compressible Aerodynamics	R		4			Sp 18, Sp 19	80
A A 322 Aerospace Laboratory II	R		3✓			Sp 18, Sp 19	75
A A 332 Aerospace Structures II	R		4			Sp 18, Sp 19	80
A A 447 Control in Aerospace Systems	R		4			Sp 18, Sp 19	78

Table 5.1.4 Year 4

		Subject Area (Credit Hours)					
Course (Department, Number, Title) List all courses in the program by term starting with the first term of the first year and ending with the last term of the final year.	Indicate Whether Course is Required, Elective or a Selected Elective by an R, an E or and SE	Math & Basic Sciences	Engineering Topics Check if contains Significant Design (√)	General education	Other	Last Two Terms the Course was Offered: Year and Semester, or Quarter	Maximum Section Enrollment for the last two terms the course was offered.
Autumn Quarter							
A A 460 Propulsion	R		4			Sp 17, Au 18	82
A A 402 Viscous Fluid Mechanics	SE		3			Au 17, Au 18	43
A A 405 Introduction to Aerospace Plasmas	SE		3			Au 17, Au 18	34
A A 406 Electric Propulsion	SE		3✓			Au 17, Au 18	18
A A 448 Control Systems Sensors and Actuators	SE		3✓			W 18, Au 18	32
A A 532 Mechanics of Composite Materials *	SE		3			Au 17, Au 18	47
Free Elective	E				5	W 19, Sp 19	Various
Winter Quarter							
A A 410 Aircraft Design I (or A A 420)	R		4✓			W 18, W 19	48
A A 420 Spacecraft and Space Systems Design I (or A A 410)	R		4✓			W 18, W 19	34
A A 419 Aerospace Heat Transfer	SE		3			W 18, W 19	50
A A 440 Flight Mechanics I **	SE		3			W 18, W 19	39
A A 461 Air Breathing Propulsion	SE		3			Au 17, W 19	43
A A 462 Rocket Propulsion	SE		3			Sp 18, W 19	42
A A 540 Finite Element Analysis I *	SE		3			W 18, W 19	65
Free Elective	E				5	W 19, Sp 19	Various
Spring Quarter							
A A 411 Aircraft Design II (or A A421)	R		4✓			Sp 18, Sp 19	46

A A 421 Spacecraft and Space System Design II (or A A 411)	R		4✓			Sp 18, Sp 19	34
A A 470 System Engineering ***	SE		3			Au 17, Sp 19	68
VLPA or I & S	SE			5		W 19, Sp 19	Various
Free Elective	E				3	W 19, Sp 19	Various

TOTALS-ABET BASIC-LEVEL REQUIREMENTS			49	89	29	13		
OVERALL TOTAL CREDIT HOURS FOR COMPLETION OF THE PROGRAM		180						
PERCENT OF TOTAL			27%	49%	16%	7%		
Total must satisfy either credit hours or percentage	Minimum Semester Credit Hours		32 Hours	48 Hours				
	Minimum Percentage		25%	37.5 %				

* includes graduate students

** beginning in the 2019-20 academic year, A A 440 will be combined with A A 516.

*** includes Industrial & Systems Engineering students (jointly listed with IND E 470)

5.A.3 How the Curriculum Supports Student Outcomes

The program's curriculum is summarized in Table 5.2. The prerequisites build upon each other from the very beginning. The first year consists of mathematics and basic sciences, balanced by general education requirements. The second year the upper division mathematical courses are introduced, along with the specified engineering fundamental courses, and remaining natural sciences courses, and are balanced again with free electives. All these prerequisites make up the foundation upon which the Aeronautical & Astronautical Engineering major is built, and constitute the requirements for application to the department. These courses provide the solid foundations necessary for the students to be able to be successful in the junior year program courses.

This structure provides the students skills in mathematics, science, and engineering fundamentals during the first two years, which prepare them to work in teams and apply the fundamentals of engineering to solve problems in their discipline. Those who have already been involved in undergraduate research have the ability to conduct experiments, analyze and interpret data, work as part of a team and would have learned about the professional and ethical responsibilities necessary to be part of a research team. Those not involved in research during the first two years have the opportunity to join a research program in their junior and senior years. All students must take the three-course laboratory sequence during their junior year and the two-course capstone sequence during their senior year.

Table 5.3 on the page following Table 5.2, shows how the program courses map to the student outcomes. (Table 5.3 is the same as Table 4.13 shown in Criterion 4.)

(This space left intentionally blank; Table 5.2 follows.)

Table 5.2 Curriculum

Freshman – Autumn Quarter		Freshman – Winter Quarter		Freshman – Spring Quarter	
* MATH 124 – Calculus I	5	* MATH 125 – Calculus II	5	* MATH 126 – Calculus III	5
* CHEM 142 – Chem & Lab I	5	^ CHEM 152 – Chem & Lab II	5	* PHYS 121 – Mechanics & Lab I	5
* English Composition	5	VLPA/I&S	5	VLPA/I&S	5
Quarter Total	15	Quarter Total	15	Quarter Total	15

Sophomore – Autumn Quarter		Sophomore – Winter Quarter		Sophomore – Spring Quarter	
+ MATH 307 – Diff. Equations	3	+ MATH 308 – Matrix Algebra	3	+ A A 260 – Thermodynamics	4
* PHYS 122 – Electro & Lab I	5	+ PHYS 123 – Waves & Lab I	5	+ CEE 220 – Mechanics of Materials	4
* A A 210 – Statics	4	+ M E 230 – Kinematics & Dynamics	4	+& MATH 324 - Multivariable Calculus	3
VLPA/I&S	2	VLPA/I&S	4	VLPA/I&S/DIV	3
Quarter Total	14	Quarter Total	16	Quarter Total	14

Junior – Autumn Quarter		Junior – Winter Quarter		Junior – Spring Quarter	
A A 310 –Space Flight Mech.	4	A A 302 – Incompressible Aerodynamics	4	A A 301 – Compressible Aerodynamics	4
A A 311 – Flight Mechanics	4	A A 312 – Structural Vibrations	4	A A 322 – Aerospace Laboratory II	3
A A 320 – Aerospace Instrumentation	3	A A 321 – Aerospace Laboratory	3	A A 332 – Aerospace Structures II	4
A A 395 – Undergraduate Seminar	1	A A 331 – Aerospace Structures I	4	A A 347 – Control in Aerospace	4
+& A MATH 301 – Scientific Computing	4				
Quarter Total	16	Quarter Total	15	Quarter Total	15

Senior – Autumn Quarter		Senior – Winter Quarter		Senior – Spring Quarter	
A A 460 – Propulsion	4	A A 410 or 420 – Capstone Design I	4	A A 411 or 421 – Capstone Design II	4
A A Technical Elective	3	A A Technical Elective	3	A A Technical Elective	3
A A Technical Elective	3	A A Technical Elective	3	VLPA/I&S	5
Free Elective	5	Free Elective	5	Free Elective	3
Quarter Total	15	Quarter Total	15	Quarter Total	15

^ CHEM 152 recommended for students considering multiple engineering programs.

* Admission Requirement (completed by April 5 deadline)

+ Enrollment Requirement (completed before Autumn Qtr)

+& Enrollment Requirement (one course may be taken during Autumn Qtr)

Table 5.3 Mapping of program courses to student outcomes

Course	1	2	3	4	5	6	7	Required
AA 210	●							Y
AA 260	●							Y
AA 301	●							Y
AA 302	●	●						Y
AA 310	●							Y
AA 311	●							Y
AA 312	●							Y
AA 320	●		●			●		Y
AA 321	●		●			●		Y
AA 322	●	●	●		●	●	●	Y
AA 331	●							Y
AA 332	●							Y
AA 395				●				Y
AA 402	●						●	N
AA 405	●					●	●	N
AA 406	●	●			●	●	●	N
AA 410	●	●	●	●	●	●	●	Y*
AA 411	●	●	●	●	●	●	●	Y*
AA 419	●		●					N
AA 420	●	●	●	●	●	●	●	Y*
AA 421	●	●	●	●	●	●	●	Y*
AA 440**	●		●				●	N
AA 447	●	●					●	Y
AA 448	●	●			●	●	●	N
AA 460	●							Y
AA 461	●	●					●	N
AA 462	●	●					●	N
AA 470	●	●	●	●			●	N
AA 499	●	●	●	●	●	●	●	N
AA 532	●						●	N
AA 540	●						●	N

* Students are required to take either AA 410-411 or AA 420-421.
** beginning in the 2019-20 academic year, A A 440 will be combined with A A 516.

5.A.4 Prerequisite Structure of Program's Required Courses

The structure of the program's prerequisite courses is shown in Table 5.4 below. The courses in italic font are the ones on which Early Admission students are evaluated (see Criterion 1 Table 1.1, *et seq.*).

Table 5.4 Prerequisites for the program's required courses

MATH 124, Calculus I	*CHEM 142, Chemistry I*	AMATH 301, Scientific Computing*
MATH 125, Calculus II	*PHYS 121, Mechanics & Lab*	AA 210, Statics
MATH 126, Calculus III	PHYS 122, Electricity & Magnetism & Lab	CEE 220, Mechanics of Materials
MATH 307, Differential Equations	PHYS 123, Waves & Lab	ME 230, Dynamics
MATH 308, Linear Analysis	*ENGL, Composition*	AA 260, Thermodynamics
MATH 324, Advanced Multivariable Calculus*		

*Must be taken prior to or not later than Autumn quarter of admission

5.A.5 How Program Meets Requirements for Each Subject Area

All students in the program must complete a minimum of 38 quarter credits of college level mathematics and natural sciences, as designated by the College of Engineering. An additional 11 credits must be completed by the students in the area of natural science and mathematics as designated by the department, for a total of 49 quarter credits total for both areas, which represents, effectively, a little over a year of study. Most of these courses must be taken before upper-division admission to the Department. Laboratory experience is guaranteed through three required Physics courses, that have accompanying labs (Physics 121, 122 and 123, and the required Chemistry course (Chem 142), which also has a laboratory. The breakdown can be seen in Table 5.1.

All department students meet the program criteria for aeronautical engineering. This is demonstrated by completion of the following required courses (or their equivalents): aerodynamics (AA 301, AA 302), structures (AA 331, AA 332), propulsion (AA 360), flight mechanics (AA 311), and stability and control (AA 447). Aerospace materials is covered in the strength-of-materials course (CEE 220), the structures sequence just mentioned, by at least one lecture and laboratory in first aerospace laboratory course (AA 321), and usually in topics brought up in the Undergraduate seminar (AA 395), which all juniors must take. These courses are required of all department students.

All department students satisfy the program criteria for Astronautical engineering. Where possible, required department classes include material from both Aeronautical & Astronautical engineering, and faculty make special effort to discuss examples and assign problems from both areas. Thus, the topic of attitude determination and control appears in the following courses: Orbital Mechanics (AA 310), Flight Mechanics (AA 440), and Controls in Aerospace Systems (AA 447), space structures appear in the structures courses (AA 331, AA 332), and rocket propulsion in the propulsion course (AA 460). The space environment is covered in the following courses: Heat Transfer (AA 419), Plasma Dynamics (AA 405), Electric Propulsion (AA 406) and is also covered in the capstone Spacecraft and Space Systems design course (AA 420, AA 421) and in the undergraduate seminar (AA 395). Similarly, telecommunications is covered in AA 420 and AA 421. Space propulsion is further covered in Rocket Propulsion, AA 462.

In their senior year students must select a capstone design course sequence in either aircraft design (AA 410 and AA 411) or spacecraft and space system design (AA 420 and AA 421). These courses provide extensive design experience, and integrate most of the material the students have already learned in other courses.

5.A.6 Major Design Experiences

All undergraduate students in the department must complete a capstone design project in order to graduate. Students indicate their interest in one of several projects in autumn quarter: 1) a large team aircraft design capstone project (AA 410-411), 2) a large team space system capstone project (AA 420-421) or 3) an industry-based capstone design project. Students who are placed on an industry-based capstone design project will either register for A A 410-411 or A A 420-421, depending upon whether the project is aircraft related or space systems related. These courses are offered during the winter and spring quarters of the senior year.

In order to complete these intense two-quarter design sequences, a student must have the accumulated knowledge of two years of engineering topics. This consists of 16 quarter credits of engineering fundamentals and 58 credits of departmental required courses. In addition, 15 credits of department technical electives are required to be completed over the three academic quarters of the senior year. During two of these quarters students concurrently take one of the two capstone design courses. Students typically choose some of their technical electives based on which design sequence they are taking.

In order to be admitted to the program students must have completed two years of engineering topics, as shown on Table 5.2. The common junior year courses in the major address the engineering sciences fundamental to aerospace engineering. Some design content appears through lectures and assignments with open-ended content. An example is when an engineering objective is posed for which there maybe a number of valid solutions, and the compromise involved in choosing one is discussed or worked on. In addition, some courses, such as AA 322, Aerospace Laboratory II, include specific design projects that require oral and written reports. This process culminates in the winter quarter of the senior year, when the students must begin either the aircraft design or spacecraft and space systems design sequence (AA 410-411 or AA 420-421).

By the start of the capstone design experience there has been sufficient preparation in engineering fundamentals to allow a meaningful integrated design experience on an overall aerospace system. The students are usually split into groups that pursue different aspects of a design. Five formal contact hours per week assures sufficient time with the instructor to accomplish class objectives and student outcomes, but considerable time is devoted by the instructors to the students outside the classroom, as well. Students are encouraged to think about the real world in which their design must function. While the emphasis, of necessity, is on engineering, other issues such as economic reality, environmental constraints, manufacturability, safety, ethics, and social and political aspects are considered as well.

5.A.7 Internship Education

The department highly encourages students to participate in an internship experience as this gives students the opportunity to apply their classroom learning to real world experiences. Students who participate in an internship experience typically do so during the summer quarter. Students can earn internship credit (ENGR 321) via the UW Career Center @ Engineering office and are registered by the course administrator. All internships must be at least 50% engineering related and students must provide an offer letter in order to be registered for credit. The grading scale is credit/no credit. Full-time work earns two credits in ENGR 321; part-time work earns one credit per quarter. Up to 6 credits of ENGR 321 and A A 499 may apply towards the A&A technical elective requirement.

In order to earn credit for the internship opportunity, there are four assignments students must complete: 1) a learning objectives assignment where students reflect upon different competencies they would like gain and/or improve upon, 2) an information interview with a professional at their internship site, 3) a final assessment where students identify their specific internship tasks and their accomplishments, and 4) an employer evaluation and student reflection.

5.A.8 Materials Available for Review During ABET Visit

The materials available for review during the visit will be:

- Textbooks
- Examples of published class notes
- Examples of homework assignments and exams
- Examples of student work – homework, exams, project reports (high, medium, and low scores).

B. Course Syllabi

The course syllabi are presented in Appendix A.

CRITERION 6. FACULTY

A. Faculty Qualifications

All 16 faculty members (this includes 14 tenured or tenure-track and 2 research faculty; all full-time) in the Aeronautics & Astronautics department hold PhD degrees in an engineering discipline, with the majority of these in Aerospace (eight faculty) or Mechanical (two faculty) Engineering. Other PhD degrees held in the Department include Electrical Engineering and Physics, those degrees being directly relevant to aerospace controls and plasma physics, respectively. Leading engineering universities represented by the degrees of the faculty include Caltech, Princeton, UC Berkeley, Harvard, and Purdue. Of the 16 faculty six (more than one third) have significant previous industrial or governmental experience as employees. Several other faculty members have had, and currently have, substantial consulting relationships with aerospace industry.

The expertise of our faculty effectively covers all of the subject areas included in our undergraduate program, broadly categorized as being aerospace controls (three faculty), aerodynamics and aeropropulsion (seven), plasma physics and space propulsion (three), and aerospace structures (three). All faculty members maintain currency in their respective fields by conducting related research, in many cases with industrial collaborators (these collaborations are particularly strong in controls and structures). All faculty take their substantial classroom teaching responsibilities seriously. Further, teaching is assigned equal weight with research in both the Department's and College's promotion and tenure processes.

All faculty are members of professional societies, including the American Institute of Aeronautics and Astronautics (AIAA), American Society of Mechanical Engineers (ASME), the American Physical Society (APS), the latter in both the division of Fluid Dynamics (CFD) and Plasma Physics (PPD), the Institute of Electrical and Electronics Engineers (IEEE), the Society for Industrial and Applied Mathematics (SIAM), the American Society for Engineering Education (ASEE), and others. Such membership in professional societies is typically aligned with the faculty members' teaching expertise, as well as being reflected by their discipline group within the Department. More than a third of the faculty are fellows or associate fellows in professional societies, which serves as one indication of their accomplishments, expertise, and high level of involvement in aerospace engineering.

In addition, faculty act as advisors to the student chapters of the AIAA, our country's leading professional society for aerospace, and Sigma Gamma Tau, the national aerospace honor society. These societies and our interactions offer students leadership opportunities, outreach, outside speakers, and field trips. The Department Chair takes specific responsibility to ensure that each society is led by a qualified and active faculty member. The Department annually provides financial support for the student activities of these professional societies.

The Department has, among its many student project efforts, capstone senior design sequences in both aircraft and space systems design. These outstanding, award-winning programs are led by teams of faculty and visiting experts from the aerospace industry.

Table 6.1 summarizes the faculty qualifications. The table lists all current faculty plus those no longer in the department but who have recently taught undergraduate courses.

(This space left intentionally blank; Table 6.1 follows.)

Table 6-1. Faculty Qualifications

Aeronautics & Astronautics

Faculty Name	Highest Degree Earned- Field and Year	Rank[1]	Type of Academic Appointment[2] T, TT, NTT	FT or PT[3]	Years of Experience			Professional Registration/ Certification	Level of Activity[4] H, M, or L		
					Govt./Ind. Practice	Teaching	This Institution		Professional Organizations	Professional Development	Consulting/summer work in industry
Behçet Açikmeşe	PhD, Aero&Astro, 2002	P	T	FT	10	7	3.5		M	M	H
Robert Breidenthal	PhD, Aeronautics, 1979	P	T	FT		39	39		M	L	H
Adam P. Bruckner (Emeritus)	PhD, Mechanical & Aerospace Engr., 1972	PEM	T	PT	N/A	43	47		L	L	L
Dana Dabiri	PhD, Aerospace Engr., 1992	ASC	T	FT		17	17		H	H	L
Antonino Ferrante	PhD, Mechanical & Aerospace Engr., 2004	ASC	T	FT		10	10		M	M	L
James C. Hermanson	PhD, Aeronautics, 1985	P	T	FT	9	25	17		L	M	L
Carl Knowlen	PhD, Aero & Astro Engr., 1991	ASC	NTT	FT	28	17	17		M	M	L
Mitsuru Kurosaka	PhD, Mechanical Engineering, 1968	P	T	FT	12	41	32		L	H	L

Justin Little	PhD, Mech. & Aero. Engr., 2015	AST	TT	FT	2	3	3		M	M	L
Eli Livne	PhD, Aerospace Engr., 1990	P	T	FT	10	28	28		H	M	M
Christopher Lum	PhD, Aerospace Engr, 2009	AST	NTT	FT		11	20		M	M	L
Mehran Mesbahi	PhD, Electrical Engineering, 1996	P	T	FT	6	21	17	PE/EE	H	M	L
Kristi Morgansen	PhD, Engineering Sciences, 1999	P	T	FT		19	16		H	M	M
Marco Salviato	PhD, Mechanical Engr, 2013	AST	TT	FT	4	6	4		M	M	L
Uri Shumlak	PhD, Nuclear Engineering, 1992	P	T	FT	4	20	20		H	M	M
Owen Williams	PhD, Mechanical & Aerospace Engr., 2014	AST	NTT	FT		1	3		M	M	L
Jinkyu Yang	Ph.D., Aeronautics, 2005	ASC	T	FT	4	7	5		M	M	L

1. Code: P = Professor ASC = Associate Professor AST = Assistant Professor PE = Professor Emeritus I = Instructor A = Adjunct O = Other
2. Code: T = Tenured TT = Tenure Track NTT = Non Tenure Track
3. Code: FT = Full-time PT = Part-time Appointment at the institution.
4. The level of activity (high, medium or low) should reflect an average over the year prior to the visit plus the two previous years.

B. Faculty Workload

The workload expectations for faculty involve the three categories of teaching, research, and service. The department chair conducts annual merit reviews of all faculty, as well as meets with them to discuss their future plans and goals. From the information gleaned in these processes, the chair makes the teaching appointments for the following academic year, also taking into account each faculty member's teaching history of the previous five years, their teaching preferences, and other factors, such as major service or research commitments.

For a faculty member who is engaged in productive, externally funded research, the normal teaching load is one course (undergraduate or graduate) each academic quarter, i.e., three courses per academic year. Faculty less engaged in research or service are typically assigned four or more courses per year, and some have on occasion taught as many as five per year. Faculty with significant service activities, such as the chairs of the undergraduate and graduate program committees are given release time from teaching that is also a function of the sizes of their research programs.

For merit and promotion and tenure reviews, the three categories of work are weighted as follows: Teaching, 40%; Research, 40%; Service, 20% (service includes both UW and external activities). However, in any given academic quarter or year, the actual workload distributions of the faculty are typically different, with teaching ranging from 20% to 50% and research from 10% to 80%, as can be seen in the following table. Some faculty have particularly heavy service assignments, while new young faculty have light service assignments; thus, service can range between zero and 80% (the latter figure applies to the department chair). The data presented in Table 6.2 document the information presented in this paragraph. (Note that only those faculty members are listed who have taught undergraduate courses in at least one academic quarter in the past three years.)

(This space left intentionally blank; Table 6.2 follows.)

Table 6-2. Faculty Workload Summary

Aeronautics & Astronautics

Faculty Member (name)	PT or FT[1]	Classes Taught (Course No./Credit Hrs.) Term and Year[2]	Program Activity Distribution[3]			% of Time Devoted to the Program[5]
			Teaching	Research or Scholarship	Other[4]	
Behçet Açikmeşe	FT	AA 598 / 3 crAu 2018 AA 312 / 3 cr Wi 2019 AA 447 / 3 cr Sp 2019	15%	70%	15%	100%
Robert Breidenthal	FT	AA 504 / 3 cr, Au 2018 AA 419 / 3 cr, Wi 2019 AA 508 / 3 cr, Sp 2019 AE 520 / 4 cr, Sp 2019	50%	40%	10%	100%
Adam P. Bruckner	PT	Au 2018 AA 462 / 3 cr, Wi 2019 Sp 2019	0% 30% 5%	10% 10% 10%	N/A N/A N/A	10% 40% 15%
Dana Dabiri	FT	AA 503 / 3 cr, Au 2018 AA 302 / 4 cr, Wi 2019 AA 301 / 4 cr, Sp 2019 AA 210 / 4 cr, Sp 2019	30%	60%	10%	100%
Antonino Ferrante	FT	AA 543 / 3 cr, Sp 2019 AA 311 / 4 cr, Au 2018 AA 402 / 3 cr, Au 2018 AA 544 / 3 cr, Sp 2018 AA543 / 3 cr, Wi 2018	40%	50%	10% Sabbatical Leave at Stanford University Wi 2019	100%
James C. Hermanson	FT	AA 527 / 3 cr, Au 2018 AA 321 / 3 cr, Wi 2019 AA 322 / 3 cr, Sp 2019	50%	30%	20%	100%
Carl Knowlen	FT	AA 421 / 4 cr, Sp 2019 AA 420 / 4 cr, Wi 2010	20%	20%	60% (KWT management)	100%

		AA 421 / 4 cr, Sp 2018 AA 420 / 4 cr, Wi 2018				
Mitsuru Kurosaka	FT	AA 461 /3 cr, Wi 2019 AA 360 / 4 cr, Au 2018 AA 525 / 3 cr, Au 2018 AA 301 / 4 cr, Sp 2018 AA 524 / 3 cr, Wi 2018	50%	40%	10%	100%
Justin Little	FT	AA 498 / 3 cr, Au 2018 AA556 / 3 cr, Wi 2019	20%	70%	10%	100%
Eli Livne	FT	AA 538 / 3 cr, Au 2018 AA 530 / 4 cr, Au 2018 AA598 / 3 cr Wi 2018 AA 410 / 4 cr, Wi 2018 AA 411 / 4 cr, Sp 2018 AA 410 / 4 cr, Wi 2019 AA 411 / 4 cr, Sp 2019 AA 516 / 3 cr, Sp 2019	45%	45%	10%	100%
Christopher Lum	FT	AA 198/ 5 cr, Au 2018 AE501 / 5 cr, Au 2018 AA448 / 3 cr, Au 2018 AA440 / 3 cr, Wi 2019 AE511 / 3 cr, Sp 2019	35%	65%	0%	100%
Mehran Mesbahi	FT	AA 597/ 3 cr, Sp 2018 AA 310 / 4 cr, Au 2019	15%	70%	15%	100%
Kristi Morgansen Hill	FT	AA 580 / 3 cr, Sp 2020	10%	30%	60% (Dept. Admin, service)	100%
Marco Salviato	FT	AA210 / 4cr, Sp 2016 AA430 /3 cr Wi 2017, 2018 AA540 / 3cr Wi 2016, 2017, 2018, 2019 AA541/ 3cr Sp 2017, 2018 AA531/ 3cr Sp 2019	30%	60%	10%	100%
Uri Shumlak	FT	AA 405 / 3 cr, Au 2017	20%	65%	15%	100%

		AA 419 / 3 cr, Wi 2018 AA 559 / 1 cr, Wi 2018 AA 558 / 3 cr, Sp 2018				
Owen Williams	FT	AA320 / 3cr, Au 2018 AA598 / 3cr, Wi 2019	20%	75%	5%	100%
Jinkyu Yang	FT	AA 532 / 3 cr, Au 2018 AA 331 / 4 cr, Wi 2019 AA 332 / 4 cr, Sp 2019	30%	60%	10%	100%

1. FT = Full Time Faculty or PT = Part Time Faculty, at the institution
2. For the academic year for which the self-study is being prepared.
3. Program activity distribution should be in percent of effort in the program and should total 100%.
4. Indicate sabbatical leave, etc., under "Other."
5. Out of the total time employed at the institution.

C. Faculty Size

Although the size of the faculty is adequate for the current needs of the undergraduate program, significant additional faculty are needed to allow for program growth. Since the last ABET review the Department has seen the departure of four faculty (P. Feraboli, K. Holsapple, A. Narang-Siddarth, and S. You) but has gained three tenured/tenure-track (J. Little, M. Salviato, and Dean M. Bragg) and two research faculty (C. Knowlen and O. Williams). There are plans to hire several additional faculty over the next five years to meet emerging and ongoing department needs. Those additional hires will be critical to replace upcoming faculty retirements and to allow for continued program growth.

The current size of the faculty is sufficient to provide for mentoring of undergraduate students. This mentoring to date has been primarily through the undergraduate faculty and staff advisors and by other faculty associated with the design projects, as well as independent research projects. We are currently exploring ways to possibly expand and broaden the undergraduate mentoring and increase the faculty involvement associated with it.

D. Professional Development

Professional development opportunities in education available to our faculty include consulting services and workshops offered by the UW Center for Teaching and Learning (CTL) and the Office for the Advancement of Engineering Teaching and Learning (ET&L) in the UW College of Engineering. The latter organization is within the College of Engineering, while the former is University-wide. Our faculty also take part in workshops and conferences hosted by the ASEE and other professional organizations. In addition, the College of Engineering conducts workshops on diversity and other matters for faculty and department chairs. The University offers similar activities.

Other professional development opportunities include regular UW workshops on developing and managing grants, workshops on commercialization topics (e.g., patents, intellectual property, forming a start-up company and working with industry) hosted by the UW Center for Commercialization (C4C). There is also an annual Faculty Field Tour to allow new UW faculty to become familiar with industry and the economy throughout Washington State.

Finally, the UW offers a Faculty Fellows Program. This program orients new faculty to the University campus community. The Program is facilitated by a number of campus educators, including those who have received campus-wide teaching awards. Presenters and facilitators actively engage our new faculty members on a number of topics such as effective teaching methods and techniques, balancing the demands of successful teaching and research, etc.

The professional-development items mentioned here are basically non-financial in nature – faculty development programs that are intended to bring funding directly into faculty research efforts are presented under Criterion 8, Section E.

E. Authority and Responsibility of Faculty

The ultimate responsibility for the effective execution of the Department's undergraduate program rests with our faculty. The Department's governance is centered on the faculty, led by the Chair. Faculty decisions are generally made by vote or consensus. Administrative and policy decisions are made by the chair in consultation with faculty and staff. The undergraduate program is coordinated by the Department's Undergraduate Committee, which consists of five faculty and the staff advisor. The Committee provides for direct oversight of the undergraduate program, including admissions, curriculum, requirements, student outcomes, and plans for continuing improvements and program growth. The Undergraduate Committee regularly reports to the faculty at large, which addresses all major issues relevant to the undergraduate program. The Department in turns works with the Associate Dean for Academic Affairs in the College of Engineering to ensure that the educational program in our department fully supports the undergraduate needs of the College of Engineering, as well as coordinates, where appropriate, with other Engineering Departments at the UW.

CRITERION 7. FACILITIES

A. Offices, Classrooms and Laboratories

Introduction

The William E. Boeing Department of Aeronautics and Astronautics is headquartered in Guggenheim Hall, in which it occupies three out of four floors. The department's additional facilities include the Aerospace and Engineering Research Building (AERB), in which the department occupies ¾ of the assignable space, the Aerodynamics Laboratory Building, the Kirsten Wind Tunnel Building, and a laboratory at the Bowman Building. Guggenheim Hall and AERB are described briefly below; the two wind tunnel facilities are described in further detail in Appendix C.

Guggenheim Hall

In 1928, the Guggenheim Foundation donated funds for the construction of an aeronautics building, one of seven similar grants made nationwide. Instruction in the building began in October 1929, and the University dedicated the Daniel Guggenheim Hall of Aeronautics in 1930. The first baccalaureate degrees in aeronautical engineering were awarded that same year. This building serves as the department's headquarters and houses the classrooms used by the program, as well as some of its laboratories and its computing facilities. After many years of requests to renovate the building, the State Legislature approved funding for the endeavor in 2003. Planning started soon thereafter and construction began in April 2006. The renovation was completed in August 2007, and the refurnishing of its offices was completed the following year.

Figure 7.1 Guggenheim Hall

Aerospace and Engineering Research (AERB) Building

In 1967, the department received a grant from NASA for the construction of the Aerospace Research Laboratory, a new research facility building. Construction was completed in 1969 and the building was dedicated in 1970. The building was re-named the Aerospace and Engineering Research Building (AERB) in 1975. Although designed as a College-wide facility, this building was the result of the concerted efforts of Aeronautics and Astronautics faculty members. The building is a laboratory and office building with no formal classrooms. About 75% of its 40,000 ft^2 is occupied by AA professors, their students, research staff, and academic and research laboratories and a conference room. The building is in need of updates due to age and deferred maintenance. We are in the process of planning an office space and furniture upgrade for communal RA/TA office spaces to provide them with more modern and cohesive workstations.

Figure 7.2 Aerospace and Engineering Research Building (AERB)

Kirsten Wind Tunnel

The Kirsten Wind Tunnel (KWT) is a subsonic wind tunnel located on the central Seattle campus of the University of Washington. Built in 1936, it operates as an auxiliary enterprise led by a faculty and staff as well as a crew of undergraduate employees who gain practical experience by running tests. The UW Board of Regents approved naming the physical facility the Kirsten Aeronautical Laboratory to honor Professor F. K. Kirsten in 1948, although "Kirsten Wind Tunnel" gets more usage than "Kirsten Aeronautical Laboratory." Kirsten Wind Tunnel contains two small laboratories outside the main operating area of the tunnel test area that serve as additional laboratory space for undergraduate courses. There facility contains office spaces for the manager, test engineer, student crew and to accommodate customer use during commercial testing. KWT has a small dedicated machine shop and just underwent a data acquisition system upgrade.

Aerodynamics Laboratory

The Aerodynamics Laboratory is a Low Speed Wind Tunnel with a 3×3 test section. Its primary use is for academic testing, but it can also support sponsored research for our faculty and students.

Bowman Building

The department also has laboratory space in the Bowman Building, located near the University of Washington campus. The A&A portion of this shared-use, UW-rented engineering building contains a 1000 square foot flight arena suitable for UAV/drone testing and equipped with an ultrasonic tracking system. The space also has an operations area and an office and student space.

Offices

All faculty, staff, research and teaching assistants are housed in offices that meet or exceed state guidelines for square footage. Faculty and staff are housed in offices in Guggenheim Hall and AERB. Research and teaching assistants share communal offices in Guggenheim Hall and AERB. Typical office furnishings include a desk, chairs, and bookcases, and every faculty and staff member has either a desktop or laptop computer (only the staff are issued computers by the department; faculty are responsible for acquiring their own, either through their research programs or with personal funds). Every faculty and staff office is also equipped with a telephone.

Classrooms and associated equipment

The Department of Aeronautics and Astronautics has made major strides in improving lab, computer and classroom equipment, particularly through the renovation of Guggenheim Hall that took place in 2006-2008 and with some academic lab remodeling in 2015-16. Prior to the renovation, funds for improvements came from various internal and external sources. The Guggenheim renovation was funded largely by the State, with some infusion from private donors and the University.

Guggenheim Hall has two classrooms, having capacities of 65 and 35 students, and one large auditorium that has a capacity of 345. These rooms are under the control of the University's Classroom Services Office, and are available to all departments on campus, but our department is designated as the primary user of the 65-set and 34-seat classrooms (which are located on the main (2nd) floor of the building. In addition, the building features a department-specific Seminar Room on the 3rd floor, which is used to teach smaller classes (up to 20 students), hold tutorial sessions by teaching assistants, hold project group meetings, etc. The three main classrooms in Guggenheim Hall are equipped with advanced A/V systems that handle all modern projection and sound requirements.

Laboratory facilities

The renovation of Guggenheim Hall also resulted greatly improved laboratory spaces, which are located on the first floor (structures and composites, and fluids labs) and the main floor (AA 320/321/322 and AA 448 lab, and computer lab). One side benefit of the renovation of the building was that the machine shop formerly located in the basement of AERB was consolidated into the Guggenheim machine shop, thus freeing about 1500 ft^2 of space that was refurbished for use as the department's Space Systems Laboratory. This lab is also used to support AA 420/421, the capstone space systems design course, and independent student projects. Room 120 in AERB was remodeled and outfitted into an electronics assembly and test lab for additional AA 410/420 capstone teams to work in. Space for AA 410/411, the capstone airplane design course, has been made available in the Kirsten Wind Tunnel Building. Aerodynamics experiments are performed in our 3'x3' wind tunnel, which is the centerpiece of the department's Aerodynamics Laboratory Building (see Appendix C).

The Aerospace Instrumentation course, AA 320, features 10 electronic workstations in Guggenheim 205, where students build and test electronic circuits and instrumentation for course assignments. Some of the workstations are also used for AA 448, Control Systems Sensors and Actuators. Aerospace Lab I and II (AA 321 and AA 322) have undergone a transition over the past decade. Many old experiments were either replaced or eliminated, and new equipment was purchased. In several labs, data are gathered with LabVIEW-based data acquisition systems. Table C.1 in Appendix C provides a list of laboratory equipment available to the program.

B. Computing Resources

Departmental Computing Resources

The department's computer laboratory occupies a dedicated space in Room 212 of Guggenheim Hall with 42 general-use PCs and 1 flight simulator PC. The computer room is accessible by students on a 24-hour basis. Because the program's computing facilities amply meet our students' needs on campus and because most students have their own personal laptop or desktop computers, they rarely have a need to access any other computing facilities at the UW.

The computing infrastructure in the renovated Guggenheim Hall is a significant improvement over the past, as it features a single, large space for the computer lab, as well as support for remote Windows sessions, high resource Virtual Desktop Interfaces, and high-performance cluster computing. The computer hardware is continuously upgraded every 3 to 4 years, using funds obtained through the UW's Student Technology Fee system.

Students have access to many engineering software tools. They perform 3D modeling with SolidWorks, ANSYS, and FEMAP/Nastran for structures and heat transfer problems, Star-CCM+ for aerodynamic modeling, and STK for orbital mechanics and space dynamics problems. For particularly demanding analyses, computing can be performed remotely on the department's 11-node, 272-core Linux-based compute cluster. This cluster is modeled after the larger UW sponsored HYAK cluster. Students are introduced to computer data acquisition using LabVIEW in their Aerospace Laboratory classes, and learn MATLAB in one of the prerequisite courses, AMATH 301, taught by the Applied Mathematics Department. A detailed listing of the equipment and software available in the computing laboratory facilities is given in Appendix B.

College of Engineering Computing Resources

Computing resources available in the UW College of Engineering include:

- **Engineering Computer lab**. 36 seat lab including Engineering software, such as Matlab, Mathematica, Maple, Ansys, Abaqus, STAR-CCM+, Solidworks and more. Available M-F 8AM to 6PM
    - https://www.engr.washington.edu/mycoe/computing/labs/index
- **Remote App cluster**, available 24/7. Cluster of four servers available to all engineering students. Students can remotely connect to server and work on class assignments from home.
    - https://www.engr.washington.edu/mycoe/computing/studentresources/remoteapp.html
- **Mailing lists**. The College maintains many different mailing lists allowing staff to communicate directly with targeted groups of engineering students, such as all undergrads or grad students.
    - https://www.engr.washington.edu/mycoe/computing/coemailinglists
- **Data Center**. This room, located in the basement of Wilcox hall houses 12 racks of servers. The room is available to both departments and student groups to house their servers.
    - https://www.engr.washington.edu/mycoe/computing/datacenter.html
- **Software licensing**. The College site licenses a number of Engineering software applications and makes them available for free, or at reduced costs, to students, faculty, and staff.
    - https://www.engr.washington.edu/mycoe/computing/software/index.html
- **Maker Space**. The College supports two maker spaces, one located West of campus, the other in the North East corner. Both are located in student dormitories.
    - https://www.washington.edu/area01/labs/dabble/ Available 1pm-midnight
    - https://hfs.uw.edu/The-MILL/Maker-Space Available 8:30am - midnight

UW Wide Computing Resources for Students

Computing resources generally available to UW students include:

- **UW libraries computing labs**. UW libraries run computing labs throughout campus. Some, such as the Odegaard library, are open 24/7 near the end of each quarter. A list of software available to students can be found here:
    - https://itconnect.uw.edu/learn/technology-spaces/odegaard-learning-commons/softwarelist/
- **Research Computing club**. Engineering students can join this club and gain access to the Hyak super-computing cluster to run large jobs across multiple nodes.
    - http://students.washington.edu/hpcc/

- **STF**. The Student Technology Fee (STF), collected quarterly from every enrolled student, is used to fund initiatives requested by students, faculty and staff to supplement the technological needs of students beyond the boundaries of the classroom. See this link for proposals funded by this fee.
    - http://uwstf.org

Classroom Support Services

Classroom Support Services (CSS) provides comprehensive media support and services to students, faculty and staff at the University of Washington. The department offers a full range of audio and video expertise to the campus community while also working with students, faculty and staff to enhance classrooms with new technologies for improved information presentations and student learning outcomes.

SpaceScout

This is an internet application available to run on a smart phone which enables students to find study spots on campus.

Panopto Lecture Capture

Available to all UW students, faculty, and staff, Panopto allows the recording of any audio and video, such as a lecture, and make it available to others. Panopto is an easy-to-use online video platform that provides unlimited space for recordings and requires minimal hardware.

Visualization

The Health Sciences Academic Services and Facilities provides equipment, facilities and services for making visualization products such as large-format color print images, still photography, movies, computer animations and interactive graphical presentations in several formats.

Campus Data Network

Internet connectivity, 10Mb, 100Mb, and 1000Gb technologies, is provided into every office and laboratory in each of the College buildings. The University's Information Technology(UW-IT) department provides centralized support for the campus-wide Internet inter-building and intra-building backbone and the campus connections to the Internet, Internet2 and vBNS national networks. By employing standard 100TX/1000TX network technologies for distribution throughout each building and fiber optics service to each building from one of several campus routing centers, UW-IT provides a robust and reliable connection to the Internet for all College and campus computing resources.

The University-wide, centrally managed wireless service initiative has expanded wireless access throughout all three UW campuses including: central 24x7 management and support of the wireless network as an integral extension of the wired data network; a single point of contact for customer service; consistent security and access controls; and ongoing maintenance and operations support, including upgrades, for all three campuses.

Payment for Computing Services:

All UW students contribute quarterly to a Student Technology Fee (http://techfee.washington.edu). Funds from this program are distributed annually, based on proposal requests, to UW-IT, and university departments and programs.

All registered students must create a personal UW NetID, enabling their access to general-use-computing resources. None of the University computing labs or College computing labs charge a fee for using the facilities or equipment. Per-page fees are charged for printed output in the University facilities and pricing schedules are regularly updated at the UW web site.

Many College of Engineering departments create local student accounts for their majors and students enrolled in department courses that permit the use of laboratory equipment and facilities. Some of the College departments have established quotas on student accounts limiting disk space usage and printed output (number of pages). Account quotas are often established and adjusted based on course enrollment and instructional requirements.

C. Guidance

Students working in laboratories, whether for instructional or research purposes are instructed in the safe operation of equipment and tools, as needed. The department requires that all faculty, staff and students complete several general safety and human resource-related trainings. Many instructional lab spaces require additional safety training before students are granted access. Laboratory courses provide specific safety information at the beginning of the quarter. Guidance for the use of instructional lab equipment is provided by the department's Research Scientist/Engineers to the students and laboratory course TAs. In addition, the machine shop provides frequent classes on machine shop safety and on the proper operation of machine tools. When students begin their junior year they attend an orientation session in which they are given material describing the rules and policies governing the use of the computer laboratory. The students have to acknowledge they have read the document by signing and submitting a response sheet. Department safety is overseen by a Safety Committee (see Section 7.F).

D. Maintenance and Upgrading of Facilities

The tools, equipment, and laboratories used by students in the program are closely monitored by the department's Research Scientist/Engineers and by the Machine Shop Manager, who is also a Research Scientist/Engineer. These staff members provide technical support for the educational and research laboratories. They work closely with the instructional faculty who use the lab facilities for their classes and also with faculty performing research in these and other labs, to determine maintenance needs and identify necessary purchases to replace and update equipment and tools. The technical staff meet regularly with the department chair to keep him/her apprised of specific needs in the labs or the machine shop. Faculty also meet with the department chair, usually in concert with one or both technical staff to discuss maintenance or purchase of equipment and tools. There is also an Instructional Laboratory Committee that meets as needed, to review the status of the instructional laboratories and make recommendations to the department chair.

Computing and information technology support to the department is provided by one Senior Computer Specialist. This staff member upgrades the computer hardware continuously, every 3 to 4 years, using funds obtained through the UW's Student Technology Fee system. In addition, they keep the department's software up to date and purchase new software as needed to serve the department's and program's needs.

E. Library Services

The Engineering Library supports all programs within the College of Engineering except Chemical Engineering, which is supported by the Chemistry Librarian. Chemical Engineering materials are housed in Suzzallo Library, which is physically closer to the Department than is the Engineering Library. Support for Bioengineering is shared with the Health Sciences Library. The Engineering Library currently houses approximately 155,000 print volumes (including tens of thousands of print technical reports), over 2.75 million microfiche (of which the vast majority are technical reports), and over 13,000 reels of microfilm. The Library provides access to tens of thousands of current engineering and related subject area journals and other serial resources, primarily in electronic form. The Engineering Library is also a U.S. Patent and Trademark Resource Center (PTRC), providing access to and guidance in the use of USPTO online resources.

The facility offers a mix of individual and group study seating (including seven group study rooms) across four floors, accommodating nearly 300 users. Power is available at over 90% of the seats in the building. A computer lab on the third floor, a joint venture with the College of Engineering, contains 17 workstations with engineering productivity software. Approximately 20 other workstations with a standard UW Libraries suite of software are also available to users.

Three professional librarians, 3.675 FTE support staff, and students staff the Engineering Library. The Library is open 80 hours per week when classes are in session, with in-person reference service provided during 43 of those 80 hours. Somewhat reduced hours are in effect during summer session and during breaks between quarters. The Library provides access to substantial journal and monograph collections plus a variety of electronic databases and other resources of relevance to the various engineering disciplines and research areas within the departments of the College of Engineering (see http://www.lib.washington.edu/engineering/resources/englibdb). Virtually all of these databases and electronic collections are available from any computer on the UW network as well as remotely to all members of the UW community via an authentication process. Some databases also contain the full-text of all or a portion of the content they index.

The Engineering Library created and provides access to subject/department specific research guides, geared primarily toward student use (see the "Research Starting Points" links available at www.lib.uw.edu/engineering). A number of additional class-specific guides have been created on-demand, in collaboration with instructors. Librarians within the Engineering Library perform dozens of class-specific information literacy sessions annually, designed to meet the specific needs an instructor has for the students in her/his class. Those librarians are also available to consult with faculty and students at any time concerning research projects or other information needs.

The UW Libraries entire collection encompasses 9+ million print volumes, over one million electronic books, access to more than 180,000 electronic journals, over 250 Libraries-licensed databases, and 1.2 million locally digitized items. Reference services are available 24/7, and free digital scanning and delivery of UW Libraries print journal articles to members of the UW community is available.

The UW Libraries online catalog maintains links within catalog records which connect users to electronic full text of selected resources, be those journals, books or other electronic content. The catalog searches the holdings of libraries from 39 higher education institutions within Washington, Oregon, and Idaho. UW users can request print materials from any of the other 38 schools for delivery within a few days.

F. Overall Comments on Facilities

The department has a Safety Committee which oversees the safe operation of all department operations. The members of this committee oversee the various research and instructional laboratories, machine shop, wind tunnels, and other facilities for safety considerations. Students working in laboratories, whether for instructional or research purposes are instructed in the safe operation of equipment. In addition, the machine shop provides frequent classes on machine shop safety and on the proper operation of machine tools.

On an annual basis, the UW's Office of Environmental Health and Safety (EH&S) conducts inspections of all the department's facilities. In addition, the Seattle Fire Department also conducts regular inspections of the facilities to assure compliance with fire safety codes.

CRITERION 8. INSTITUTIONAL SUPPORT

A. Leadership

Governance in the Department of Aeronautics & Astronautics is centered on the faculty, led by the Department Chair. Responsibility for the undergraduate program lies primarily with the Undergraduate Committee, which is headed by the Committee Chair and supported by the Manager of Undergraduate Programs. The Undergraduate Committee handles all routine aspects of the undergraduate program. Significant changes to the undergraduate program involving, for example, changes to the curriculum, new degree programs, requirement changes, and measures to accommodate program growth are normally brought to the faculty by the Undergraduate Committee for faculty decision, which is generally made by vote or consensus. The management of the undergraduate program is adequate to ensure the quality and continuity of the program.

B. Program Budget and Financial Support

1. <u>Program budgeting process</u>

As is the case in all units at the University of Washington, the academic program budget for the Department of Aeronautics and Astronautics is determined biennially by the University, based on allocations from the State of Washington and is distributed to the College which then distributes it based on activity based budgeting (ABB). The state budget (General Operating Fund) accounts for only 23% of the department's total operating budget, with the remaining 77% coming primarily from federal grants and contracts, private donations, and other sources, a situation which is typical of most departments in the College of Engineering. In the 2017-2019 biennium the department's state and local budget allocations were $7.6 Million, including benefits. The state and local allocations fund the salaries of 17 regular faculty (including 3 vacant positions), 5.85 administrative and 1 technical staff, and approximately 10 teaching assistants per quarter. These state funds do not include allocations for general operations.

The state budget for the department does not contain any specific allocations for equipment acquisition, replacement, or repair; nor for faculty travel, publications, staff development, or other necessary activities, thus, we rely on, revenue from the delivery of our professional masters prorgam, the Masters of Aerospace Engineering (MAE) through the UW's Continuum College, from indirect cost fund recoveries from grants and contracts, and from private donations and endowments to achieve some of our program goals. This year, we have been successful in obtaining additional funds for computer hardware upgrades through proposals to the UW's Student Technology Fee program.

2. <u>Support of teaching in terms of graders, teaching assistants, teaching workshops, etc.</u>

Teaching Assistants (TAs) and graders are assigned to undergraduate courses based on enrollment.

- **Standard Lecture**
    - 25-40 Students = 1 Grader
    - 41-60 Students = 1 TA
    - 61-90 Students = 1 TA + 1 Grader

- **Lab Course**
    - 1 TA per 30 Students

- **Large Lecture** (e.g., Engineering Statics, Thermodynamics)
    - 1 TA + 1 Grader per 100 Students

Per the collective bargaining agreement with students in the TA and Grader job titles, TAs can be assigned both logistical, grading, and instructional duties to support a course. Graders may provide basic logistical and grading support but cannot provide independent instruction (including office hours)

Pedagogical guidance for TAs is provided by the UW Center for Teaching & Learning (CTL) and the Office for the Advancement of Engineering Teaching & Learning (ET&L). CTL conducts an annual "TA Conference" to support TAs in their roles as educators. Specific goals include helping TAs provide high-quality learning experiences, as well as facilitating their professional development. Our department required first-time TAs to attend the conference each year. ET&L provides engineering-specialized support, on request, to TAs and instructors who would like in-class observation, feedback, and instructional coaching.

There is no formal program and no funding available, at the University or in the College of Engineering, to address the professional development of faculty. Such professional development takes place on an ad-hoc basis in each department. In our department, it consists primarily of mentoring faculty at all levels, by encouraging them to apply for grants and contracts, participate actively in professional societies, attend teaching workshops and seminars, and do all that is required to advance in their careers. This mentoring comes from the department Chair, from senior faculty, and from peer faculty. In addition, the department has a formal process in place for the peer evaluation of teaching. As all departments in the University, our department also has a well-established set of criteria for promotion and tenure, and for the review of faculty performance on an annual basis.

3. Resources to acquire, maintain, and upgrade infrastructures, facilities, and equipment

The College of Engineering (CoE) works with the University of Washington administration to obtain Minor Modification Funds as needed, however no such funds have been approved by the UW in the past three biennia in spite of such requests. However, the CoE infrastructure group does work with individual departments to secure staffing and, in some cases, will oversee individual renovation projects to support lab upgrades and maintenance as needed to continue to meet ABET requirements. These projects are requested on an individual basis. Priorities for these projects are set by the individual departments with CoE support.

In addition to this funding mechanism and cycle, the CoE infrastructure group works with individual departments to secure staffing and, in some cases, will oversee individual renovation projects. These projects are requested on an individual basis. Priorities for these projects are set by the individual departments with CoE support.

4. Adequacy of resources

The resources outlined in this section are adequate to allow undergraduate students to attain all student outcomes currently expected for this program. However, the Department is continually working to further strengthen and grow the undergraduate program. Further program growth will depend on the resources required to increase the size of the faculty, the number of teaching assistants and support staff, and increased capacities in classrooms and laboratories.

C. Staffing

The department is directly supported by a staff of 17, broadly grouped into administrative, fiscal, academic advising, technical support, facilities, computing, and Wind Tunnel. One staff member supports the Washington State Joint Center for Aerospace Technology Innovation (JCATI). Each category is discussed below.

1. Administrative: The department Chair is directly supported by a Chair's Assistant and the department Administrator. The Assistant to the Chair is responsible for academic human resources, event management and general chair support. The Administrator provides professional leadership in the areas of fiscal, HR, facilities and operational responsibilities. A Program Manager provides support in the area of public information and web editing, event management, stewardship and special projects. Part-time student assistants are also employed as receptionists and general office support duties. There is an increasing need for an additional human resources staff member.
2. Fiscal: The fiscal team provides fiscal support to the department, including pre- and post-award administration, purchasing, travel, equipment inventory and insurance, and more. The fiscal staff of the Department currently consists of a Grant & Contracts Manager who supervises a Budget/Fiscal Analyst and several student assistants who perform budget reconciliation. Reporting to the Administrator are a Fiscal Specialist 2, a Fiscal Specialist 1, and a 50% FTE Administrative Assistant who perform payroll, purchasing and reimbursement activities. The adequacy of the fiscal staff at present is good. In the last two years this team has focused on timely customer service, and identifying processes and workflow efficiencies. Most recently adding on the administrative assistant. The fiscal specialist 1 is retiring in June 2019 and will be replaced as quickly as possible.
3. Academic Advising: Student Services (academic advising and counseling) is provided by the department's Academic Services unit. This team includes a dedicated Undergraduate Program Advisor, Graduate Program Advisor, and Director of Academic Services. Staff members are well trained (all have master's degrees) and widely considered competent and effective in their roles. However, the growing enrollments and growing demand for administrative infrastructure strains the ability of advisors to meet all student needs while also supporting administrative needs such as classrooms, course scheduling, clerical tasks, etc. Administrative support for logistical operations of student and academic services is strongly desired.

4. Technical Support: Technical support for the department's education and research functions is provided by four Research Scientist/Engineer staff, one of whom does fabrication work and manages the department's machine shop. Two staff provide technical support for the research and educational laboratories in the department. One is assigned to the Kirsten Wind Tunnel as a test engineer. The technical staff is currently stretched to provide all of the services needed for academics and research.

5. Facilities

   The 50% FTE Administrative assistant listed in Fiscal above also fills the role of 50% FTE building coordinator, facilities management and equipment inventory. This position was filled in February 2019. This has been an under-addressed need in the department for a long time. This addition adequately address this needs at present.

6. Computing: Computing and information technology support to the Department is provided by a Senior Computer Specialist as well as additional support from CoE computing. All units are provided centralized IT support via a helpdesk. Two work-study students assist the Senior Computing Specialist with IT infrastructure and staffing. Computing/IT support is good. We will be soon transitioning the staff person in this role as he has just resigned. We will be doing a full review to see if there are areas for improvement with regard to the position's roles and responsibilities in the department.

7. Wind Tunnel: The Kirsten Wind Tunnel is served by an 80% Business Manager, who is in turn supported by a test engineer (classified as a research scientist/engineer). These two staff supervise the operations crew, which consists entirely of students (typically 8-14, depending on the time of year). The adequacy of the Wind Tunnel support personnel is excellent, however, there is a proposal to increase the professional staffing by one FTE and reduce the temporary hourly staffing to achieve greater efficiency.

Staff Retention

The last several years the annual merit process provides between 2-4% that is College funded; not by the state. This means that it is difficulty to reward excellent performance. Furthermore, many of our essential staff are funded on non-state funding sources thus the merit increase burden is on the Department to fund. The College of Engineering has implemented unit adjustment process if the Department leadership has justification for increasing staff members' salary for retention or market adjustments. We have provided in grade salary adjustment as necessary when a staff members job responsibilities and performance have increased. We offer staff opportunities to telework or allow for alternative schedules in order to enhance staff satisfaction, productivity, and morale.

Staff Training

The University of Washington Professional & Organizational Development organization has a comprehensive course catalog and offers numerous opportunities for staff training. The department strongly supports employees' ongoing training, both for current duties and for career development.

D. Faculty Hiring and Retention

The normal sequence for new faculty hiring in Aeronautics & Astronautics consists of the following steps:

1. The faculty, working with the Department Chair identifies new area(s) or vacant position(s) targeted for faculty hiring, consistent with the long-term hiring plan submitted to the College.
2. Approval for the new hire(s) is obtained from the College of Engineering.
3. A Search Committee is appointed by the Department Chair.
4. The Search Committee and Department Chair compose advertisement(s) for the new position(s). The advertisement(s) is/are submitted via *Interfolio* for College of Engineering (CoE) and Academic Human Resources (AHR) approval. Once approved, the ad(s) is/are placed (usually in a national print journal) soliciting applications for a faculty position.
5. Candidates submit their applications, which are reviewed by the departmental Search Committee.
6. A short list of top candidates is developed and the candidates are interviewed.
7. The Chair and Department faculty discuss all finalists vet the final candidate(s), and a vote is taken of eligible faculty.
8. The successful candidate(s) are contacted and the Chair discusses terms of the formal offer(s).
9. The formal offer(s) are submitted to the College for approval before being sent to the candidate(s).
10. Should the candidate(s) accept the formal offer, the Department submits appointment paperwork into *Workday* for CoE and Provost approval. AHR prepares the appointment materials for the Board of Regents or Provost, as appropriate.
11. The Provost and Board of Regents review and approve the new appointment(s).
12. The Provost's Office notifies the new faculty member(s) that their appointment has been approved and welcomes them to the UW.

Strategies employed by the College of Engineering to retain current qualified faculty members include:

1. <u>Retention Salary Adjustments</u> – Upon application and recommendation by the department Chair, the Dean may request retention salary adjustments for qualified faculty through the Office of the Provost. Retention salary adjustments receive case-by-case review. As a general principle, retention salary adjustments are expected to provide a minimum 5% salary increase. Generally, an individual may not receive a retention salary adjustment for a period of three years from the effective date of the most recent retention adjustment.

2. A/B Retention Salary Adjustments The College of Engineering and the University of Washington recognize that, in selected cases, special salary considerations are warranted for purposes of retention. An A/B Salary Model may be used for this purpose. The Model has two components. The first component (A) is a tenured faculty member's state supported salary level. The second component (B) is obtained from externally generated funds ("soft money"). The (B) component relies on the faculty member's ability to generate sufficient and consistent funding from eligible grants and contracts or other self-sustaining activities. The (B) component amounts to between 10 and 30% of the base salary. The total salary paid to the faculty member is then the sum of the A and B components. Faculty are still responsible for carrying out all responsibilities associated with the state support allocated to the position. Overall teaching loads, research and service commitments, student supervision, and all other faculty duties remain unchanged. All A/B salary arrangements are proposed by the department Chair, subject to approval by the Dean and Provost.

E. Support of Faculty Professional Development

The University of Washington and the College of Engineering have extensive faculty professional development programs. Many of them focus on new faculty but some are for all faculty.

University of Washington Programs

The University of Washington's Faculty Fellows Program

This program orients new faculty to the University campus community. The Program is facilitated by a number of campus educators, including those who have received campus-wide teaching awards. Presenters and facilitators actively engage our new faculty members on a number of topics including, but not limited to, effective teaching methods and techniques, use of technology in and outside of the classroom, promotion of diversity and inclusion, and balancing the demands of successful teaching and research. The program is offered every year, during the first or second week of September, a few weeks before the start of the Fall quarter. The program is for all new faculty members at the three UW campuses (Seattle, Bothell, and Tacoma).

The University of Washington's Royalty Research Fund

The UW awards grants of up to $40,000 to faculty to advance new directions in research, in particular:

- in disciplines for which external funding opportunities are minimal;
- for faculty who are junior in rank;
- in cases where funding may provide unique opportunities to increase the applicant's competitiveness for subsequent funding.

Funded projects often lead to new creative activities or scholarly understandings, new scholarly materials or resources, and significant data or information that increase a faculty member's chances of obtaining new external funding.

Bridge Funding

The University of Washington Provost's Office provides bridge funding to support faculty to span the gap in critical research programs. Under this program faculty can receive up to $50,000 (with a required 1:1 match from the department or College to give a total of up to $100,000) to help them maintain research productivity during gaps in external funding while they seek to obtain external funding for their research. More information is available at: https://www.washington.edu/research/or/bridge-funding-program

College of Engineering Programs

Office for the Advancement of Engineering Learning & Teaching (ET&L)

The ET&L office supports the University of Washington, College of Engineering's mission by taking a leadership role in developing and supporting engineering instructional excellence. The ET&L office offers one-on-one consultations, formative course assessments, faculty workshops, learning communities, in-class presentations, and education resources and expertise. The ET&L approach to professional faculty development begins with meeting and resolving the immediate concerns of faculty members. Simultaneously ET&L helps faculty members place their improvement efforts within a larger cycle of ongoing improvement, implementation, and assessment. Workshop topics and specific instructional development activities and resources are identified through close cooperation with engineering faculty members. ET&L services are available to all faculty members in the College of Engineering. The overwhelming majority of new ECE faculty take advantage of ET&L in-class evaluations and discussions of their teaching. Nearly all report that the process and feedback has been very helpful in improving and fine tuning their teaching methods and style. For more information see https://www.engr.washington.edu/mycoe/oaetl.

ADVANCE: Increasing the Participation and Advancement of Women in Academic Science and Engineering Careers

The University of Washington received a $3,750,000 National Science Foundation (NSF) ADVANCE Institutional Transformation grant in 2001 to increase the participation and advancement of women in academic science and engineering careers. With the grant, it formed the ADVANCE Center for Institutional Change (CIC) which is housed in the College of Engineering. The vision of the CIC is a campus in which all science, technology, engineering, and mathematics (STEM) departments are thriving, all faculty are properly mentored, and every STEM faculty member is achieving his or her maximum potential. UW believes that cultural changes that are designed to help underrepresented groups invariably help all groups and improve the environment for everyone.

The CIC implements programs designed to eliminate existing barriers and to precipitate cultural change at both the departmental and the institutional level. One of the successful strategies the ADVANCE program has employed to impact departmental culture and climate are quarterly leadership workshops for department chairs, deans, and emerging leaders. Prior to ADVANCE, department chairs received little or no professional development beyond their initial orientation to the department chair position. The ADVANCE workshops provide those in leadership positions with a better understanding of the structural, psychological, and behavioral barriers to the advancement of faculty. For each half-day workshop, the department chairs are encouraged to invite an emerging leader so that other faculty can be exposed to academic leadership issues. These workshops have served as a forum for cross-college networking and professional development, and are the only regular department chair professional development gathering on campus. These workshops help develop the next set of department chairs in STEM departments. Department chairs have stated these workshops are the "boot camp" they never got and evaluations of the workshops have been uniformly high.

The UW ADVANCE program has had great impact. ASEE 2017 Engineering by the Numbers reports UW has 24.2% women faculty in engineering compared to a national average of 17%. Further, out of the top 50 schools with engineering programs as ranked by US News & World Report, UW ranks second highest for percentage of women faculty in engineering.

Figure 8-1 shows the percentage of women faculty in Engineering, compared to the national average.

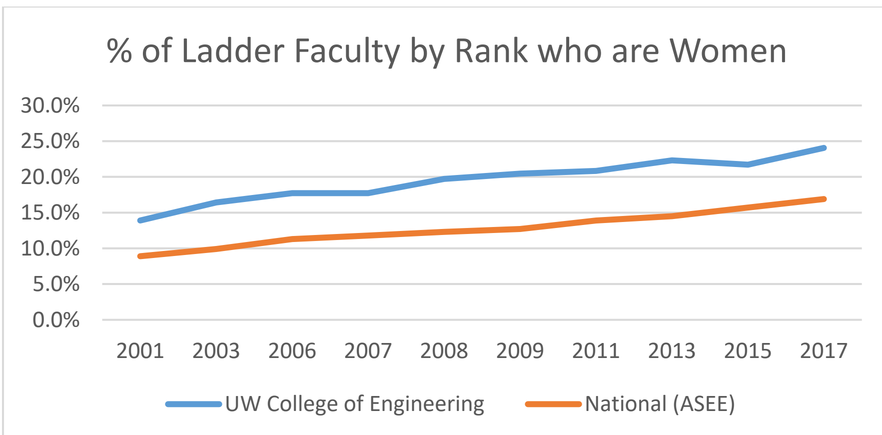


Figure 8-1 Percentage of Women Faculty

The ADVANCE CIC also hosts a quarterly Pre-Tenure Faculty Workshop Series for all junior faculty members in STEM fields. This program provides participants the resources to establish a strong academic foundation and navigate the tenure process. Past topics have included the following: managing time and resources; understanding the tenure and promotion process; recruiting and mentoring graduate students; setting up a lab; building strong mentoring relationships; establishing peer networks and support structures; and applying for prestigious national grants, including the National Science Foundation's CAREER award. The workshops have been attended by 298 unique faculty members between 2003 and 2018.

APPENDIX A – COURSE SYLLABI

Table 5.3 Mapping of program courses to student outcomes

Course	1	2	3	4	5	6	7	Required
AA 210	●							Y
AA 260	●							Y
AA 301	●							Y
AA 302	●	●						Y
AA 310	●							Y
AA 311	●							Y
AA 312	●							Y
AA 320	●		●			●		Y
AA 321	●		●			●		Y
AA 322	●	●	●		●	●	●	Y
AA 331	●							Y
AA 332	●							Y
AA 395				●				Y
AA 402	●						●	N
AA 405	●					●	●	N
AA 406	●	●			●	●	●	N
AA 410	●	●	●	●	●	●	●	Y*
AA 411	●	●	●	●	●	●	●	Y*
AA 419	●		●					N
AA 420	●	●	●	●	●	●	●	Y*
AA 421	●	●	●	●	●	●	●	Y*
AA 440**	●		●				●	N
AA 447	●	●					●	Y
AA 448	●	●			●	●	●	N
AA 460	●							Y
AA 461	●	●					●	N
AA 462	●	●					●	N
AA 470	●	●	●	●			●	N
AA 499	●	●	●	●	●	●	●	N
AA 532	●						●	N
AA 540	●						●	N

* Students are required to take either AA 410 & 411 or AA 420 & 421.
** beginning in the 2019-20 academic year, A A 440 will be combined with A A 516.

AA 210 COURSE DETAILS

TITLE: Engineering Statics
CREDITS: 4
FORMAT & SCHEDULE: Lecture, 3 hours / week; Quiz, 2 hours / week

FACULTY CONTACT: James Hermanson

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Applies vector analysis to equilibrium of rigid body systems and subsystems. Includes force and moment resultants, free body diagrams, internal forces, and friction. Analyzes basic structural and machine systems and components.

COURSE OVERVIEW & LEARNING OBJECTIVES:

This course is an introduction to the concepts of force systems, static equilibrium, friction, centroids, centers of gravity, shear and moment diagrams, and moments of inertia. It provides the basic tools necessary for the analysis of any engineering system in which materials transmit forces. Course Objectives:

1. Work comfortably with basis engineering mechanics concepts required for statics problems.
2. Identify an appropriate structural system and isolate it from its environment.
3. Model the problem using good free-body diagrams and accurate equilibrium equations
4. Identify and model various types of loading and support conditions that act on structural systems.
5. Apply relevant mathematical, physical and engineering principles to analyze and solve problems.
6. Understand the meaning of centers of gravity, centroids, and moments of inertia using integration and composite body methods.
7. Communicate the solution to all problems in an organized and coherent manner and elucidate the meaning of the solution in the context of the problem.

COURSE REQUIREMENTS

PREREQUISITES: 1) minimum grade of 2.0 in either MATH 126 or MATH 136
2) Minimum grade of 2.0 in PHYS 121

REQUIRED TEXTBOOK: *Engineering Mechanics: Statics*, 5th Ed by Bedford & Fowler

COURSE TOPICS

1. Vector in 2D and 3D; vector products, projection of vectors parallel and perpendicular to a line
2. Introduction to forces; free body diagram; pulleys and springs
3. Introduction to moment, moment vector; moment about a line; couple
4. Equivalent systems; wrench
5. Objects in equilibrium; static determinacy and indeterminacy
6. Types of supports in 2D and 3D; proper and improper support
7. Two-force and three-force members
8. Truss analysis; method of sections; method of joints; space trusses
9. Frames and simple machines
10. Centroids; distributed loads; Pappus-Guldinus theorems; center of mass
11. Moment of inertia, mass moment of inertia; parallel axis theorem, perpendicular axis theorem
12. Transformations of moment of inertia; Mohr circle
13. Friction; friction in wedges
14. Beams; internal forces and moments; axial force, shear force and bending moment diagrams
15. Equilibrium via minimization of total potential energy; stability of equilibrium configuration

AA 260 COURSE DETAILS

TITLE:	Thermodynamics
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 3 hours / week Quiz, 2 hours / week
FACULTY CONTACT:	James Hermanson

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Introduction to the basic principles of thermodynamics from a macroscopic point of view. Emphasis on the First and Second Laws and the State Principle, problem solving methodology.

COURSE OVERVIEW & LEARNING OBJECTIVES:

This course will provide an introduction to the basic principles of thermodynamics from a macroscopic point of view. Students will learn about the concepts of energy and entropy and how to apply these concepts to analyze engineering systems. At the end of this course, students should be able to:

1) Understand and determine properties of real substances, use property tables, and apply the ideal gas law.
2) Analyze open and closed systems by applying the first law of thermodynamics. Perform energy balances, determine heat and work transfers.
3) Apply the second law to analyze systems and control volumes.
4) Understand basic cycles including Otto, Rankine, and Brayton cycles.

COURSE REQUIREMENTS

PREREQUISITES: 1) minimum grade of 2.0 in either CHEM 140, CHEM 142, CHEM 144, or CHEM 145
2) minimum grade of 2.0 in either MATH 126, MATH 129, or MATH 136
3) minimum grade of 2.0 in PHYS 121

REQUIRED TEXTBOOK:
Thermodynamics, An Engineering Approach, 8th Edition, Çengel and Boles

COURSE SCHEDULE

Week & Topic

1 Units, Systems, Processes, Cycles, State Postulate, Pressure, Energy, Heat Transfer, Work, 1st Law of Thermodynamics

2 Energy Conversion Efficiencies, Pure Substances, Phase change, P-V Diagrams, Propery Tables, Ideal Gas, Other Equations of State, Compressibility

3 Moving Boundary Work, Energy Balance, Polytropic Processes, Specific Heats, Internal Energy, Enthalpy

4 Mass Balance for Control Volumes, Flow Work, Flow Energy, Nozzles, Diffusers, Turbines, Compressors, Throttle Valves

5 2nd Law, Thermal Resevoir, Heat Engine, Refrigerator, Reversible and Irreversible Processes, Carnot Principles

6 Entropy, Entropy Changes, Isentropic Processes, Entropy Property Diagrams, T ds Relations, Entropy Change of Liquids, Solids, Ideal Gasses

7 Reversible Steady-Flow Work, Efficiency, Entropy Balance, Analysis of Power Cycles, Otto Cycle, Diesel, Sterling, Ericsson, Brayton Cycles

8 Brayton with Regeneration, Intercooling, Reheating, Ideal Jet-Propulsion Cycles, Second Law Analysis

9 Carnot and Rankine Vapor Cycles, Regenerative Rankine Cycle

10 2nd Law Analysis of Vapor Power Cycles, Cogeneration, Refrigerators and Heat Pumps, Vapor-Compression Refrigeration Cycles, Review

AA 301 COURSE DETAILS

TITLE:	Compressible Aerodynamics
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Dana Dabiri

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Covers aerodynamics as applied to the problems of performance of flight vehicles in the atmosphere; kinematics and dynamics of flow fields; thin airfoil theory; compressible fluids; one-dimensional compressible flow; and two-dimensional supersonic flow.

COURSE OVERVIEW & LEARNING OBJECTIVES:

The main goal of this course is to learn about supersonic aerodynamics. Upon completion of this course, students will be able to:

1. Derive the equations of motion for a fluid.
2. Apply the equations of motion towards understanding normal shocks, and solve problems involving normal shocks.
3. Apply the equations of motion towards understanding oblique shocks and expansion wave, and solve related problems.
4. Understand supersonic flow through nozzles, wind tunnels and diffusers, and be able to design them.
5. Apply the equations of motion towards understanding compressible subsonic flows and solving related problems.
6. Use software program of choice (MATLAB, C++, PowerPoint, CorelDraw, etc) to design and present.

COURSE REQUIREMENTS

PREREQUISITES: Either A A 260 or M E 323.

REQUIRED TEXTBOOK: *Fundamentals of Aerodynamics*, John D. Anderson

COURSE SCHEDULE

Topics

Thermodynamics 1st law ; Compressibility, divergence, math identities, fluid models ; Equations of inviscid, compressible flow: continuity

Equations of inviscid, compressible flow : Momentum and Energy ; Substantial derivatives and stagnation conditions ; Normal shock equations and speed of sound

Energy equation ; Compressibility and shock wave properties ; Pitot tube and Hydraulic Jump

Oblique shocks ; Shock interactions and reflections ; Prandtl-Meyer expansion waves

Shock-expansion applications ; lift and drag coefficients ; Equations for Quasi-1D flow ; Nozzles

Under/over-expanded nozzle flows, diffusers ; Linearized velocity potential & comp. Corrections : Prandtl-Glauert & others

Critical Mach number, sound barrier, area rule ; Linearized supersonic flow

Numerical methods : supersonic flow ; Viscous flow : Introduction and N.S. equations

Subsonic couette flow

Introduction to boundary layers

AA 302 COURSE DETAILS

TITLE:	Incompressible Aerodynamics
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Dana Dabiri

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Aerodynamics as applied to the problems of performance of flight vehicles in the atmosphere. Kinematics and dynamics of flow fields; incompressible flow about bodies. Thin airfoil theory; finite wing theory.

COURSE OVERVIEW & LEARNING OBJECTIVES:

The main goal of this course is to learn about subsonic incompressible aerodynamics. Upon completion of this course, students will:

1. Understand basic properties of fluids.
2. Be able to develop the mass and momentum conservation laws.
3. Be able to calculate velocity fields, streamlines, vorticity and circulation.
4. Have the ability to solve airfoil problems using superposition.
5. Be able to calculate the lift and induced drag of a 3D wing.

COURSE REQUIREMENTS

PREREQUISITES: 1) PHYS 123
2) Either AMATH 351, MATH 136, or MATH 307.

REQUIRED TEXTBOOK: *Fundamentals of Aerodynamics*, John D. Anderson

COURSE SCHEDULE

Topics

Forces and moments, coefficients and COP ; BPT therom, flow similarity ; line, surface, volume integrals, continuity equation

Momentum equation ; Energy equation, substantial derivative, divergence ; stream/streak/pathlines

Angular velocity, vorticity, strain, circulation, streamfunction ; velocity potential, Bernoulli venturi tube &low ; Speed tun. Pitot tube pressure coefficient, Laplace equation

Uniform flow, source/sink ; uniform flow + source/sink ; Doublet, non-lifting flow over sylinder ; Vortex flow, lifting flow over vortex flow

Kutta-Joukowski, source panel method ; Circular cylinder example ; NACA nomenclature, vortex sheet

Kutta condition, Kelvin's circulation theorem ; Thin Airfoil theory

Cambered airfoil aerodynamic center, vortex panel method ; Finite wing introduction, vortex filament, Prandtl lifting line theory

Elliptical lift distribution ; General lift distribution, Aspect Ratio ; Lifting surface theory : Vortex Lattice Method ; Delta wing

3D flow

Introduction to viscous flow

AA 310 COURSE DETAILS

TITLE:	Orbital and Space Flight Mechanics
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Mehran Mesbahi

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Newton's law of gravitation. Two-body problem, central force motion, Kepler's laws. Trajectories and conic sections. Position and velocity as functions of time. Orbit determination and coordinate transformations. Rocket dynamics, orbital maneuvers, Hohmann transfer. Interplanetary trajectories, patched conics. Planetary escape and capture. Gravity assist maneuvers.

COURSE OVERVIEW & LEARNING OBJECTIVES:

The topics that we will cover in this course include: two body problem, central force motion, Kepler’s Laws, conic sections, orbit determination, rocket dynamics, orbital maneuvers, Hohmann transfer, interplanetary trajectories, and depending on time/students’ interest, spacecraft attitude dynamics or restricted three-body problem. Course Objectives:

1. Students will have a general understanding of space flight systems and how different engineering disciplines contribute to the success of missions, both in near-Earth orbit and interplanetary orbits.
2. Students will understand the application of Newton’s laws for particles and show skill in applying them to model spaceflight trajectories.
3. Students will understand the application of modern computational tools for the calculation of spacecraft motion.

COURSE REQUIREMENTS

PREREQUISITES: M E 230

REQUIRED TEXTBOOK: *Orbital Mechanics for Engineering Students*, 3rd ed by H. D. Curtis, Elsevier

COURSE SCHEDULE

Topics

Mathematics and physics background, notation and basic concepts

Two-body problem, Kepler's laws

Geocentric orbits, orbit shaping, orbital transfers

Orbital elements, orbit determination

Interplanetary missions, sphere of influence, patched conics

Rocket equation, staging

Relative motion

Restricted three-body problem

Spacecraft attitude dynamics

AA 311 COURSE DETAILS

TITLE:	Atmospheric Flight Mechanics
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Antonino Ferrante

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Applied aerodynamics, aircraft flight "envelope," minimum and maximum speeds, climb and glide performance. Range and endurance, take-off and landing performance, using both jet and propeller power plants. Longitudinal and dynamic stability and control, wing downwash, stabilizer and elevator effectiveness, power effects. Lateral and directional stability and control.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Flight mechanics is the study of how airplanes lift themselves and perform at flight. This course covers basic understanding of standard atmosphere, basic aerodynamics, shapes or airplanes, airplane performance, stability and control, propulsion and hypersonic flight.

Students completing this course in good standing will be able to:

1. Apply dimensional analysis
2. Explain how a wing generates lift and identify drags generated from various sources
3. Explain the performance of the aircraft based on their geometry and aerodynamic coefficients
4. Explain the static and dynamic stability
5. Explain or calculate the thrust gained from reciprocating engine-propeller combination, and jet propulsion engine
6. Identify fundamentals of hypersonic regime

COURSE REQUIREMENTS

PREREQUISITES: M E 230

REQUIRED TEXTBOOK: *Introduction to Flight*, 8th Ed by John D. Anderson, McGraw-Hill, 2012

COURSE SCHEDULE

Topics

Introduction to flight mechanics ; Dimensional analysis

Standard atmosphere

Basic aerodynamics

Aerodynamic shapes of airplanes

Airplane performance

Stability and control

Propulsion

Hypersonic flight

AA 312 COURSE DETAILS

TITLE:	Structural Vibrations
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Behcet Acikmese

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Vibration theory. Characteristics of single and multi degree-of-freedom linear systems with forced inputs. Approximate methods for determining principal frequencies and mode shapes. Application to simple aeroelastic problems.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Introduce students to the fundamental elements of linear analysis of mechanical systems. Fundamental tools of modeling will be introduced first. Then basic mathematical analysis tools will be introduced both in time domain, via state-space models, and in frequency domain, via Fourier analysis.

Course Objectives:

1. Students will learn the fundamentals of modeling and analysis of linear mechanical systems.
2. Students will be prepared to perform practical control system design using computer aided control systems design tools.

COURSE REQUIREMENTS

PREREQUISITES: M E 230

REQUIRED TEXTBOOK: *None required.*

COURSE SCHEDULE

Topics

Overview of complex numbers, Laplace transforms, linear algebra, modeling rigid body dynamics

Modeling continuous systems : vibrating string, torsional shafts, beams, and approximations via discretizations

Time-domain representations of mechanical systems : 2^{nd} order ODEs and state-space forms

Frequency domain function models : Impulse response, transfer functions

Basics of time-domain analysis, eigenvalues and eigenvectors

Basics of frequency domain analysis, Bode plots, Fourier analysis

AA 320 COURSE DETAILS

TITLE:	Aerospace Instrumentation
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 2 hours / week; Lab 2 hours / week
FACULTY CONTACT:	Jim Hermanson

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Hands-on laboratory experience for understanding the design and function of electronic circuits and instrumentation utilized in aerospace engineering. Topics include Ohm's law, Kirchoff's laws, DC and AC circuits, passive and active components, op-amps and comparators, sensors, signal conditioning, electromechanical systems and actuators, digital systems, and data acquistion.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will understand the structure and requirements of technical report writing.
2. Students will be able to use and understand passive and active circuit components and sensors, and their characteristics.
3. Students will be able to design power supplies and simple circuits for aerospace instrumentation.
4. Students will understand sensor calibration and signal conditioning as applied to wind tunnels and other aerospace systems.
5. Students will understand bandwidth limitations of aerospace instrumentation circuits.

COURSE REQUIREMENTS

PREREQUISITES: PHYS 123

REQUIRED TEXTBOOK: Scherz, P. and Monk, S., *Practical Electronics for Inventors*, 4th Ed., McGraw-Hill, 2013.

COURSE SCHEDULE

Topics

Overview of electronic systems in aerospace

Basic concepts : voltage, current, Ohm's law, Kirchhoff's laws, resistors and resistor networks. Use of digital mulimeter.

Capacitors, RC circuits, temporal behavior ; Wheatstone bridge, filters. Use of oscilloscope and function generator.

Inductors, transformers, diodes, RL and RLC circuits, rectification, DC power supplies for aerospace applications.

Active components : transistors, op-amps, comparators ; gain and feedback. Switches, amplifiers, comparators, analog integrators and differentiators, signal conditioning for aerospace sensors.

Sensors for wind tunel and other aerospace applications : pressure sensors, strain gages, thermocouples, inclinometers. Sensor characteristics : signal level, dynamic range, accuracy.

Light sensors and optical communication, corrent-to-voltage converter.

Electromechanical systems and acuators, DC motor characteristics, control systems.

AA321 COURSE DETAILS

TITLE:	Aerospace Laboratory I
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 1 hour / week; Lab, 2 hours / week
FACULTY CONTACT:	James Hermanson

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

The design and conduct of experimental inquiry in the field of aeronautics and astronautics. Laboratory experiments on supersonic flow, structures, vibrations, material properties, and other topics. Theory, calibration, and use of instruments, measurement techniques, analysis of data, report writing.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will be able to perform wind tunnel tests and reduce wind tunnel data.
2. Students will be able to test materials, apply strain gauges, and measure stresses.
3. Students will understand how to take data on dynamic systems in vibration.
4. Students will be able to perform supersonic wind tunnel tests and reduce the resulting tunnel data.
5. Students will know how to write good lab reports.

COURSE REQUIREMENTS

PREREQUISITES: 1) A A 311
2) A A 320

REQUIRED TEXTBOOK: *None*

COURSE SCHEDULE

Topics

Sphere drag

Materials testing

2D wing

Stress analysis with strain gages

3D wing

Stresss concentration

Ludwieg Tube/Supersonic Flow

Beam bending and vibration

Propeller performance

AA 322 COURSE DETAILS

TITLE:	Aerospace Laboratory II
CREDITS:	3
FORMAT & SCHEDULE:	Individual Team Meetings with Instructor, TBA Individual Team Meetings with Project Mentor, TBA
FACULTY CONTACT:	James Hermanson

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Design and conduct of experimental inquiry in the field of aeronautics and astronautics. Student groups propose, design, build, and conduct laboratory experiments in one of the following broad topic areas: aerodynamics, structures, propulsion, or energetics. Results are presented in written and oral reports.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will be able to propose, design, build, and perform experiments on a topic of their choice.
2. Students will be able to utilize aerospace instrumentation and equipment to perform experiments.
3. Students will know how to take, reduce and analyze experimental data.
4. Students will know how to write good lab reports and make good oral presentations.

COURSE REQUIREMENTS

PREREQUISITES: A A 321 with minimum grad of 1.7.

REQUIRED TEXTBOOK: *None*

COURSE SCHEDULE

Example Projects:

- Pulsed cold-gas rocket (static)
- Vertical wind turbine
- Plasma thruster
- Electrothermal rocket (static)
- Morphing wing aerodynamics
- Aerodynamic decelerators
- CubeSat prototype lofted by weather balloon
- Rocket-boosted glider
- Aerodynamics of an annular wing
- Characteristics of a tailless airplane

Milestones

1. Weekly Summaries & Notebooks
2. Midterm Report
3. Midterm Peer Evaluation
4. Final Report
5. Final Oral Presentation
6. Final Peer Evaluations

AA 402 COURSE DETAILS

TITLE: Viscous Fluid Mechanics
CREDITS: 3
FORMAT & SCHEDULE: Lecture, 3 hours / week

FACULTY CONTACT: Antonino Ferrante

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Introduction to fluid mechanics, dimensional analysis, effects of gravity on pressure, kinematics, conservation of mass and momentum, control-volume method, conservation of energy, vorticity and viscosity, viscous effects, Navier-Stokes solutions, and boundary layers.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Students completing this course in good standing will be able to:

1. Apply dimensional analysis.
2. Explain and calculate the effects of gravity on pressure.
3. Calculate vorticity, circulation, streamlines, streaklines and pathlines.
4. Apply conservation of mass, momentum and energy.
5. Derive and apply Navier-Stokes solutions.
6. Derive and apply boundary layer equations.

COURSE REQUIREMENTS

PREREQUISITES: 1) MATH 324
2) A A 301

REQUIRED TEXTBOOK: *Basic Fluid Mechanics*, 5th ed, D. C. Wilcox, DCW Industries, 2012

COURSE SCHEDULE

Topics

Introduction to fluid mechanics; Dimensional Analysis

Effects of gravity on pressure

Kinematics

Conservation of mass & momentum

Control-volume method

Conservation of energy

Vorticity and viscosity

Viscous effects

Navier-Stokes solutions

Boundary layers

AA 405 COURSE DETAILS

TITLE:	Introduction to Aerospace Plasmas
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	Uri Shumlak

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Development of introductory electromagnetic theory including Lorentz force and Maxwell's equations. Plasma description. Single particle motions and drifts in magnetic and electric fields. Derivation of plasma fluid model. Introduction to plasma waves. Applications to electric propulsion, magnetic confinement, and plasmas in space and Earth's outer atmosphere.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Students completing this course in good standing will be able to:

1. Calculate the electric and magnetic fields for given electrode and current geometry.
2. List Maxwells equations and explain their significance.
3. Describe the Lorentz force and its source.
4. Determine charged particle motion in the presence of electric and magnetic fields.
5. Apply adiabatic invariants to determine particle trapping in Earth’s dipole field.
6. Explain the presence of the Van Allen radiation belts.
7. Describe the effect of the interplanetary magnetic field on Earth’s atmosphere.
8. Identify the 3 magnetohydrodynamic waves.
9. List the general types of electric plasma thrusters and their applicability.
10. Describe frozen flow losses in electrothermal thrusters.
11. Calculate the Child-Langmuir saturation thrust in electrostatic thrusters.
12. Differentiate among electromagnetic thrusters.
13. Design an electric plasma thruster for a particular mission and determine the thruster efficiency, power requirements, and compare to other options.
14. List some common fusion reactions and the energy released.
15. Explain the basic principles of magnetic plasma confinement.
16. Identify open and closed magnetic confinement configurations.

COURSE REQUIREMENTS

PREREQUISITES: 1) MATH 324
2) PHYS 123

REQUIRED TEXTBOOK: 1. *Introduction to Plasma Physics and Controlled Fusion* by F.F. Chen
2. *Introduction to Electrodynamics* by D.J. Griffith

COURSE SCHEDULE

Topics

Electricity and magnetism: electrostatics, magnetostatics, electrodynamics and Maxwell's equations, superposition principle for E-M fields, Poynting's theorem

Definition of plasma state: Debye shielding, plasma frequency, role of collisionality

Single particle motion in electric and magnetic fields: guiding center drifts, adiabatic invariants, magnetic mirrors

Fluid theory: 2-fluid model of plasma, derivation of MHD equations, resistivity and generalized Ohm's law, waves in plasma

Electric propulsion: specific impulse, Tsiolkovsky rocket equation, energy considerations

Electrothermal thrusters: resistojets, arcjets, frozen flow losses

Electrostatic thrusters: Child-Langmuir law, Hall-effect thrusters

Electromagnetic thrusters: conveyor belt problem, MPD arc, MHD thrusters

Magnetic confinement fusion: thermonuclear fusion reactions, Lawson criteria, magnetic confinement configurations

Space plasmas: solar wind, interplanetary magnetic field, Van Allen radiation belts

AA 406 COURSE DETAILS

TITLE:	Electric Propulsion
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 1 hour / week; Lab 3 hours / week
FACULTY CONTACT:	Justin Little

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Core concepts in the field of electric space propulsion, including plasma formation via strong electric fields, characterization using electric probes, and performance measurements. Includes required lab sections.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Students completing this course in good standing will be able to:

1. Characterize and evaluate EP thrusters.
2. Apply and analyze data from industry standard diagnostics.
3. Objectively evaluate thruster performance based on past studies in the literature.
4. Reduce large data sets using statistical methods.
5. Identify and characterize sources of uncertainty.
6. Compare measured quantitates to established analytical models.
7. Present results in the form of a concise scientific report.

COURSE REQUIREMENTS

PREREQUISITES: A A 405 must be taken simultaneously.

REQUIRED TEXTBOOK: None

COURSE SCHEDULE

Topics

Introduction, Motivation, and Applications: what is electric propulsion (EP?), rocket equation and specific impulse, benefits of EP, important parameters, EP tradeoffs, EP system considerations, prospect of EP for in-space propulsion

Fundamentals and Operation Principles: review of the electromagnetic force, plasmas as a conductive fluid, Maxwell's equations, Thruster performance metrics, electric thruster classifications, thruster operating principles

The Path from R&D to Flight: Recent increase in use of EP systems, applications on the horizon, remaining frontiers, how to go from an idea to reality

Test Methods, Vacuum Chambers: vacuum in space, vacuum in the laboratory, EP testing requirements, types of vacuum pumps, vacuum system design, case studies

Test Methods, Plasma Diagnostics: the need for plasma diagnostics in EP, what do we want to measure?, electric probes, optical diagnostics

Test Methods, Thrust Measurements: thrust stand principles, types of thrust stands, stand performance metrics, calibration and error sources, other techniques

Test Methods, Lifetime Testing: EP lifetime requirements, current lifetime testing practices, challenges with lifetime testing, lifetime qualification components, movement towards standardization

AA 410-411 COURSE DETAILS

TITLE:	Aircraft Design I-II
CREDITS:	8 (4 + 4)
FORMAT & SCHEDULE:	Lecture & Individual Team Meetings, TBA
FACULTY CONTACT:	Kristi Morgansen

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

410: Conceptual design of a modern airplane to satisfy a given set of requirements. Estimation of size, selection of configuration, weight and balance, and performance. Satisfaction of stability, control, and handling qualities requirements.

411: Preliminary design of a modern airplane to satisfy a given set of requirements. Estimation of size, selection of configuration, weight and balance, and performance. Satisfaction of stability, control, and handling qualities requirements.

COURSE OVERVIEW & LEARNING OBJECTIVES:

The purpose of this two-quarter design course sequence is to integrate the material and techniques from traditional engineering science lecture and examination classes into a holistic "project-oriented" work environment that is typical in the engineering design industry.
Course Objectives:

1. Students will be able to carry out conceptual design and sizing of airplane systems.
2. Students will understand the interaction between key relevant disciplines, and the trade-offs, in airplane systems design.
3. Students will understand the function of aircraft components and subsystems and how they might be designed.
4. Students will understand systems engineering issues as they relate to mission goals and requirements.
5. Students will experience self-organization, delegation, teamwork, communication to peers and visitors, fiscal and schedule maintenance.
6. Students will experience hands-on prototyping and testing of their chosen design and supporting coupons and models.

COURSE REQUIREMENTS

PREREQUISITES: 1) A A 320
2) A A 311
3) A A 332
4) A A 460

REQUIRED TEXTBOOK: None

COURSE SCHEDULE

Milestones

WINTER

Intro / Prep Lectures

Systems Requirement Review (SRR)

Preliminary Design Review (PDR)

SPRING

Critical Design Review (CDR)

Final Design Review (FDR)

Final Poster Session

AA 419 COURSE DETAILS

TITLE:	Aerospace Heat Transfer
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	Uri Shumlak

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Fundamentals of conductive, convective, and radiative heat transfer with emphasis on applications to atmospheric and space flight.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will be able to derive the governing equations of heat transfer.
2. Students will be able to analytically and numerically solve problems of heat conduction and convection.
3. Students will be able to analytically solve problems of radiative heat transfer.

COURSE REQUIREMENTS

PREREQUISITES: 1) MATH 307
2) PHYS 123

REQUIRED TEXTBOOK: Bergman, Lavin, Incropera, DeWitt. Fundamentals of Heat and Mass Transfer, 7th Edition, Wiley, 2011

COURSE SCHEDULE

Topics

Motivation, Context, Fundamental Physics, Modes of Heat Transfer

Governing Equations, Nondimensional Parameters -- Fo,Bi,Pr

Heat Conduction, Thermal Diffusion, 1D Steady-State, Boundary Conditions, Fins

Thermal Resistance, Axisymmetric Geometries, 2D/3D Steady-State, Separation of Variables

Transient Conduction, Lumped Capacitance, Numerical Methods

Heat Convection, Conservation Laws, Similarity Analysis, External Flows, Internal Flows

Fully Developed, Laminar & Turbulent Flows, Free Convection, Heat Exchangers

Heat Radiation, Blackbody, Kirchhoff's Law, Absorptivity/Reflectivity, Opacity

Radiative Transfer Between Surfaces, View Factors

AA 420-421 COURSE DETAILS

TITLE:	Spacecraft and Space Systems Design I-II
CREDITS:	8 (4 + 4)
FORMAT & SCHEDULE:	Lecture & Individual Team Meetings, TBA
FACULTY CONTACT:	Kristi Morgansen

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

420: Design of space systems and spacecraft for advanced near-Earth and interplanetary missions. Astrodynamics, space environment, space systems engineering. Mission design and analysis, space vehicle propulsion, flight mechanics, atmospheric entry, aerobraking, configuration, structural design, power systems. thermal management, systems integration. Oral presentations and report writing. Design topics vary.

421: A continuation of A A 420. Course content varies from year to year and is dependent on the design topic chosen for A A 420. Prerequisite: A A 420.

COURSE OVERVIEW & LEARNING OBJECTIVES:

The purpose of this two-quarter design course sequence is to integrate the material and techniques from traditional engineering science lecture and examination classes into a holistic “project-oriented” work environment that is typical in the engineering design industry.
Course Objectives:

1. Students will understand the function of spacecraft subsystems and how they might be designed.
2. Students will understand the state of the art in spacecraft system and subsystem design and the trade-offs between them.
3. Students will experience choosing and narrowing high-level mission goals and requirements into specific tasks for design.
4. Students will experience self-organization, delegation, teamwork, communication to peers and visitors, fiscal and schedule maintenance.
5. Students will experience hands-on prototyping and testing of their chosen.

COURSE REQUIREMENTS

PREREQUISITES: 1) A A 301
2) A A 310
3) A A 332
4) A A 460

REQUIRED TEXTBOOK: None

COURSE SCHEDULE

Milestones

WINTER

Intro / Prep Lectures

Systems Requirement Review (SRR)

Preliminary Design Review (PDR)

SPRING

Critical Design Review (CDR)

Final Design Review (FDR)

Final Poster Session

AA 447 COURSE DETAILS

TITLE:	Control in Aerospace Systems
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Behcet Acikmese

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Overview of feedback control. Dynamic models for control systems design including ODE, transfer function, and state-space. Linearization of nonlinear models. Analysis of stability, controllability, observability, time/frequency domain techniques. Frequency of response design techniques. Design of control systems via case studies.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Introduces students to the fundamental elements of systems theory and control and teaches the necessary concepts and tools required to perform analysis and design of feedback control systems. Both classical control (frequency domain) and modern state-space based control (time domain) theories and techniques are introduced. The theory will be demonstrated by means of several applications of modern aerospace systems.

Course Objectives:

1. Students will understand the fundamentals of linear control systems.
2. Students will be able to conduct practical control system design using computer aided control systems design tools.

COURSE REQUIREMENTS

PREREQUISITES: 1) Minimum grade of 1.7 in A A 312
2) M E 230
3) MATH 308

REQUIRED TEXTBOOK: *None*

COURSE SCHEDULE

Topics

Overview of feedback control

Dynamic modeling feedback control systems

State space and frequency domain models

Brief review of behavior of BIBO stable systems

Root locus analysis for stability

Feedback control system specifications

Nyquist stability analysis

Loop shaping for feedback control design

AA 448 COURSE DETAILS

TITLE:	Control Systems Sensors and Actuators
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 3 hours / week; Lab 3 hours / week
FACULTY CONTACT:	Kristi Morgansen

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Overview of feedback control. Study of control systems components and formulation of their mathematical models. Discussion and analysis of amplifiers, DC servomotors, magnetic-actuators, accelerometers, potentiometers, shaft encoders and resolvers, proximity sensors, and force transducers. Experimental determination of component models and model parameters. Includes hands-on laboratory component.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will understand how data acquisition systems work.
2. Students will be able to model a real system using mathematical approximations.
3. Students will understand how to design experiments to identify system parameters for a given mathematical model.
4. Students will be able to actively control a hardware system in real time.
5. Students will be able to compare experimental data with simulations.

COURSE REQUIREMENTS

PREREQUISITES: A A 447

REQUIRED TEXTBOOK: NONE

COURSE SCHEDULE

Topics

Review of modeling dynamic systems-Laplace transform, traditional methods for solving differential equations, transfer function and state space representations, deriving equations of motion for mechanical and electrical systems.

Review of electromechanical laboratory practices.

Basic measuring and measurement recording devices.

Elements of electromechanical system modeling.

Modeling and analysis of dynamical systems in time and frequency-domains.

Analog and digital sensors for motion measurements.

Force and torque sensors.

Digital transducers.

Actuators: DC motors, electromagnets, etc.

Analog and digital filtering controllers.

Design of controllers including PID and state feedback systems.

Microcontroller (Arduino) software and hardware development.

AA 460 COURSE DETAILS

TITLE:	Propulsion
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Mitsuru Kuosaka

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Study of the aero- and thermodynamics of jet and rocket engines. Air-breathing engines as propulsion systems. Turbojets, turbofans, turboprops, ramjets. Aerodynamics of gas-turbine engine components. Rocket vehicle performance. Introduction to space propulsion.

COURSE OVERVIEW & LEARNING OBJECTIVES:

At the end of this course, student will

1. Understand the aero- and thermodynamics of jet and rocket engines.

2. Understand the fundamentals of turbojets, turbofans, turboprops, ramjets, scramjets, and hybrid engines.

COURSE REQUIREMENTS

PREREQUISITES: Minimum grade of 1.7 in A A 301

REQUIRED TEXTBOOK: NONE

COURSE SCHEDULE

Topics

Introduction to propulsion

Fundamentals of thermos and gas dynamics as related to propulsion

Rockets

Satellite orbital mechanics and electric propulsion

Gas turbines

Advanced propulsion: detonation engines

AA 461 COURSE DETAILS

TITLE:	Air Breathing Propulsion
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	Mitsuru Kuosaka

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Examines gas turbine engine design methodology. Covers aerodynamics or gas dynamics of air breathing engine components: inlets, compressors, turbines, and nozzles. Studies the on-design and off-design performance of gas turbine engines. Includes combustion, emissions, noise, and advanced air breathing propulsion systems.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will understand the aerothermodynamics of air breathing engines.
2. Students will understand the fundamentals of compressor aerodynamics and performance.
3. Students will understand the fundamentals of turbine aerodynamics and performance.
4. Students will understand the fundamentals of the on-design and off-design performance of turbine engines and engine components.
5. Students will understand the fundamentals of inlet and exhaust nozzle performance.
6. Students will understand the basics of gas turbine emissions and noise.

COURSE REQUIREMENTS

PREREQUISITES: A A 360

REQUIRED TEXTBOOK: NONE

COURSE SCHEDULE

Topics

Compressors

Turbines

Inlets

Engine acoustics

Exhaust nozzle

Combustors

Chemical kinetics

Emission

AA 462 COURSE DETAILS

TITLE:	Rocket Propulsion
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	James Hermanson

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Covers the physical and performance characteristics of chemical rocket propulsion systems. Includes rocket equations, mass ratios, staging, flight performance, nozzle theory and design, combustion thermochemistry, propellant categories, fuels, oxidizers, monopropellants, rocket system components and materials and rocket design principles.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. Students will understand the fundamentals of rocket propulsion.
2. Students will become proficient at carrying out performance calculations for typical chemical rocket systems.
3. Students will understand the reasons behind rocket component selection and design based on mission requirements and physical properties of propellants.
4. Students will be able to design an entire rocket system to meet specified mission requirements.

COURSE REQUIREMENTS

PREREQUISITES: A A 260

REQUIRED TEXTBOOK: *Rocket Propulsion Elements*, 9th ed., G.P. Sutton and O. Biblarz, John Wiley & Sons, Inc., 2017.

COURSE SCHEDULE

Topics

Fundamentals of rocket propulsion, rocket equation, staging, flight performance, propellant categories.

Thrust, efficiency, nozzle flow, types of nozzles, two-phase flow, flow separation.

Combustion thermochemistry, thermochemical codes.

Liquid rocket engines and propellants (fuels, oxidizers, monopropellants).

Solid propellant rockets, hybrid rockets, propellants, design issues.

Thrusters and systems, materials and process engineering, component selection, design approaches.

AA 470 COURSE DETAILS

TITLE:	Systems Engineering
CREDITS:	4
FORMAT & SCHEDULE:	Lecture, 4 hours / week
FACULTY CONTACT:	Susan Murphy

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Concepts of system approach, system hierarchies, functional analysis, requirements, trade studies, and other concepts used to define and integrate complex engineering systems. Introduction to risk analysis and reliability, failure modes and effects analysis, writing specifications, and lean manufacturing. Jointly offered with IND E 470.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1) Students will be able to quantitatively evaluate system interfaces.
2) Students will be able to quantify risk and reliability.
3) Students will be able to write a simple component specification.
4) Students will be able to develop elements of a project plan.

COURSE REQUIREMENTS

PREREQUISITES: None

REQUIRED TEXTBOOK: None

COURSE SCHEDULE

Topics

System Engineering Definition
Project Management Overview
Program Documentation
Integrating Program Management and Systems Engineering
Scheduling and Communication
System Architecture & Requirements
Specifications and Specialties
Execution and Controlling
Managing Risk
Production System Design
Supply Chain Management
Life Cycle Engineering
Verification/Validation
Lean and Improving Existing Systems
Failure Resolution

AA 516 COURSE DETAILS

TITLE:	Stability and Control of Flight Vehicles
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	Behcet Acikmese

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Static and dynamic stability and control of flight vehicles in the atmosphere. Determination of stability derivatives. Effects of stability derivatives on flight characteristics. Flight dynamic model. Responses to control inputs and external disturbances. Handling qualities. Control system components, sensor characteristics. Stability augmentation systems.

COURSE OVERVIEW & LEARNING OBJECTIVES:

This course on Flight Stability and Control provides a dynamical systems understanding of flight behavior through development of appropriate methodologies- critical for flight-vehicle design and control. This subject is concerned with reaction of a flight vehicle to externally or internally generated disturbances.

Students will develop a thorough understanding of

1. small perturbation theory,
2. equations of motion of a rigid vehicle,
3. modeling forces and moments of the vehicle,
4. flight simulation,
5. longitudinal and lateral-directional modes,
6. feedback stability augmentation and autopilot design.

COURSE REQUIREMENTS

PREREQUISITES: A A 440 or permission of instructor

REQUIRED TEXTBOOK: *Aircraft Control and Simulation*, 3rd ed., Stevens, Lewis.

COURSE SCHEDULE

Topics

Mathematical vector spaces and physical vector quantities; direction cosine matrices; angular velocity vector

Transport theorem; reference frames (ECI, ECEF, NED,…); translational equations of motion; flat-Earth assumptions

Translational flat-Earth EOMs; Euler angles; Euler angle kinematics; rotational equations of motion

Scalar flat-Earth 6-DOF equations of motion; wind frame, stability axes; wind-relative velocity, airspeed, angle of attack, sideslip angle; aerodynamic force & moment coefficients

Relating aerodynamic moments to different reference points; static analysis, neutral point, and static stability; normalized angular rates; aerodynamic coefficient component buildup; numerical differentiation and simulation

Local analysis of nonlinear models with linear methods; trim & linearization; flat-Earth wind-axes force equation; analytical linearization of EoMs; stability derivatives

Dynamic stability; longitudinal modes: short-period, Phugoid; Lateral-directional modes: Dutch roll, roll subsidence, spiral; short-period approximation

Phugoid approximation; handling qualities; flight control: stability augmentations systems (SAS), control augmentation systems (CAS), autopilots

AA 532 COURSE DETAILS

TITLE:	Mechanics of Solids
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	Jinkyu Yang

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Analysis and design of composite materials for aerospace structures. Micromechanics. Anisotropic elasticity. Laminated plate theory. Thermo-viscoelastic behavior and fracture of composites. Prerequisite: coursework in mechanics of materials or permission of instructor.

COURSE OVERVIEW & LEARNING OBJECTIVES:

Course Objectives:

1. To provide the student with knowledge of basic mechanics of composite materials with the focus on composite analysis (not design).
2. Students will learn composite fabrication processes briefly. Limited hands-on fabrication sessions will be provided to students.
3. Students will develop a simple computation code using MATLAB to calculate the responses of composites under static loading conditions.

COURSE REQUIREMENTS

PREREQUISITES: NONE

REQUIRED TEXTBOOK: *Mechanics of Composite Structures,* 1st ed., Laszlo P. Kollar, George S. Springer, Cambridge University Press.

COURSE SCHEDULE

Topics

General introduction-Definition and types of composites, advantages and disadvantages, applications

Micromechanics-(Modified) rue of mixture, Harpin-Tsai equations

Constitutive equations-Stress-strain relationships, Plane stress/strain conditions, coordinate transformation

Classical laminate theory

Structural analysis-thin plates, sandwich plates, beams

Failure criteria

Other-composite manufacturing, fatigues/fracture

AA 540 COURSE DETAILS

TITLE:	Finite Element Analysis I
CREDITS:	3
FORMAT & SCHEDULE:	Lecture, 3 hours / week
FACULTY CONTACT:	Marco Salviato

COURSE DESCRIPTION (Catalog Short Form, 50 words Max):

Formulation of the finite element method using variational and weighted residual methods. Element types and interpolation functions. Application to elasticity problems, thermal conduction, and other problems of engineering and physics.

COURSE OVERVIEW & LEARNING OBJECTIVES:

The course will give the basic formulations of the finite element analysis methods and applications to the analysis and design of aerospace vehicles. One-, two-, three- dimensional problems including trusses, beams, box beams, plane stress and plain strain analysis. Use of Finite Element Software.

Learning Objectives:

1. Students will understand the fundamentals of finite element analysis.
2. Students will understand the formulation of the finite element method using vibrational and weighted residual methods.
3. Students will be able to solve implicit problems such as in elasticity, thermal conduction, and other problems of engineering and physics.
4. Students will be able to use ABAQUS to model and solve problems.

COURSE REQUIREMENTS

PREREQUISITES: None

REQUIRED TEXTBOOK: *A First Course in the Finite Element Method*, 6th ed., Daryl L. Logan

COURSE SCHEDULE

Topics

Introduction to the history, background and applications of the Finite Element Method (FEM)

Direct matrix method: all of the matrix manipulations introduced; force trusses, beams

Solution of truss problems using minimum potential energy

Method of Weighted Residuals to obtain the element equations. General one- and two-dimensional problems: approximation functions, Galerkin methods, Petrov-Galerkin, Least Squares, Collocations, etc.

Isoparametric Elements

Two dimensional and three dimensional finite element types

Numerical integration

Higher order interpolations and elements in one, two and three dimensions

Basics of heat transfer by using the FEM

Review of structural vibrations problems and solution with the FEM

APPENDIX B – FACULTY VITAE

List of Faculty

Tenured or Tenure-Track Faculty (current):

Açıkmeşe, Behcet	Associate Professor
Breidenthal, Robert E.	Professor
Dabiri, Dana	Associate Professor
Ferrante, Antonino	Associate Professor
Hermanson, James C.	Professor
Jarboe, Thomas R.	Professor
Kurosaka, Mitsuru	Professor
Little, Justin	Assistant Professor
Livne, Eli	Professor
Mesbahi, Mehran	Professor
Morgansen, Kristi A.	Professor and Chair
Salviato, Marco	Assistant Professor
Shumlak, Uri	Professor
Yang, J.K.	Associate Professor

Tenured or Tenure-Track Faculty (former):

Bragg, Michael B.	Professor and Dean
Lin, Kuen	Professor
Narang, Anshu	Assistant Professor
Waas, M. Anthony	Professor and Chair
You, Setthivoine	Assistant Professor

Emeritus Faculty:

Bruckner, Adam P.	Professor Emeritus

Research Faculty (current):

Knowlen, Carl	Research Associate Professor
Williams, Owen	Research Assistant Professor

Research Faculty (former):

Golingo, Raymond	Research Associate Professor
Lum, Chrisopher	Research Assistant Professor

Affiliate Faculty:

Susan Murphy	Affiliate Associate Professor (Boeing)

Notes :

This list includes faculty in the department at the time this report was submitted.

FTT and Research Faculty listed in Italic font have not taught undergraduate courses in the past three years. Research faculty normally do not have teaching assignments.

The list of Vitae which follows contains only those faculty who have taught undergraduate courses during the past two years.

The vitae of departed faculty are not provided.

1. Name: Behçet Açıkmeşe

2. Education
Ph.D., School of Aeronautics and Astronautics, Purdue University, 2002
M.S., School of Mechanical Engineering, Purdue University Indianapolis, 1996
B.S., Civil Engineering, Middle East Technical University, 1992

3. Academic experience
University of Washington, Professor, 2019-present, Associate professor 2016-2019
The University of Texas, Austin, Assistant Professor, 2012-2015
Purdue University, Visiting Assistant Professor, 2003

4. Non-Academic Experience
NASA Jet Propulsion laboratory, Senior Technologist 2003-2012

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

Associate Fellow of AIAA, since 2013

Senior Member of IEEE, since 2008

7. Selected Honors and awards

UW Faculty Appreciation for Career Education & Training Celebration, 2019

Best paper award, *Asian Journal of Control*, 2015

NSF CAREER Award, 2015

NASA Group Achievement Awards, 2014, 2015

8. Service activities
Member, AIAA Electric Propulsion Technical Committee, 2019-present
Mentor for *NSF – Washington State Academic RedShirt (STARS)*, 2019
Faculty Technical Lead – UW A&A CubeSat Team, 2018-2019
Co-Organizer, "The Next Step for In-Space Propulsion," Special Session Panel, *AIAA Propulsion and Energy Forum*, Indianapolis, IN, 2019
Co-Organizer, "Young Visionary in Electric Propulsion," Paper Competition, *35th International Electric Propulsion Conference*, Atlanta, GA, 2017

9. Publications/Presentations in the Past 5 Years (selected)

- M. El Chamie, D. Janak, and B. Açıkmeşe, "Markov decision processes with sequential sensor measurements," *Automatica*, vol. 103, pp. 450–460, 2019.
- M. El Chamie, Y. Yu, B. Açıkmeşe, and M. Ono, "Controlled Markov processes with safety state constraints," *IEEE Transactions in Automatic Control*, vol. 64, no. 3, pp. 1003–1018, 2019.
- Y. Yu, B. Açıkmeşe, and M. Mesbahi, "Bregman parallel direction method of multipliers for distributed optimization via mirror Markov mixing," *The IEEE Control Systems Letters*,vol. 2, no. 2, pp. 302–306, 2018.
- M. El Chamie and B. Açıkmeşe, "Safe Metropolis–Hastings algorithm and its application to swarm control," *System and Control Letters*, vol. 111, pp. 40–48, 2018.
- N. Demirer, M. El Chamie, and B. Açıkmeşe, "Safe markov chains for density control of on/off agents with observed transitions," *IEEE Transactions in Automatic Control*, vol. 63, no. 5, pp. 1442 – 1449, 2018.

- D. P. Schar, D. Dueri, B. Açıkmeşe, J. Benito, and J. Casoliva, "Flight testing of real-time convex optimization based guidance algorithm G-FOLD - guidance for fuel optimal large divert," *AIAA Journal of Guidance, Control, and Dynamics*, No. 40, pp. 213–229, 2017.
- D. Dueri, B. Açıkmeşe, D. P. Scharf, and M. W. Harris, "Customized real-time interior-point methods for onboard powered descent guidance," *AIAA Journal of Guidance, Con- trol, and Dynamics*, no. 40, pp. 197–212, 2017.
- U. J. Aarsnes, B. Açıkmeşe, A. Ambrus, and O. M. Aamo, "Robust controller design for automated kick handling in managed pressure drilling," *IFAC Journal of Process Control*, vol. 47, pp. 46–57, November 2016.
- N. Demir, U. Eren, and B. Açıkmeşe, "Decentralized probabilistic density control of mobile agent swarms with spatial and temporal safety constraints," *Autonomous Robots*, vol. 39, no. 4, pp. 537–554, 2015.
- B. Açıkmeşe, N. Demir, and M. W. Harris, "Convex necessary and sufficient conditions for density safety constraints in markov chain synthesis," *IEEE Transactions on Automatic Control*, vol. 60, no. 10, pp. 2813–2818, 2015.
- U. Eren, D. Dueri, and B. Açıkmeşe, "Constrained reachability and controllability sets for planetary precision landing via convex optimization," *AIAA Journal of Guidance, Control, and Dynamics*, vol. 38, no. 11, pp. 2067–2083, 2015.
- B. Açıkmeşe, M. Mandić, and J. L. Speyer, "Decentralized observers with consensus filters for distributed discrete-time linear systems," *Automatica*, vol. 50, no. 4, pp. 1037–1052, 2014.
- B. Açıkmeşe and D. S. Bayard, "Markov chain approach to probabilistic guidance for swarms of autonomous agents," *Asian Journal of Control*, vol. 17, no. 4, pp. 1105–1124, 2015.
- M. W. Harris and B. Açıkmeşe, "Lossless convexification of non-convex optimal control problems for state constrained linear systems," *Automatica*, vol. 50, no. 9, pp. 2304–2311, 2014.
- B. Açıkmeşe, S. W. Sell, A. M. S. Martin, and J. J. Biesiadecki, "Mars science laboratory flyaway guidance, navigation, and control system design," *AIAA Journal of Spacecraft and Rockets*, vol. 51, no. 4, pp. 1227–1236, 2014.
- M. W. Harris and B. Açıkmeşe, "Minimum time rendezvous of multiple spacecraft using differential drag," *AIAA Journal of Guidance, Control, and Dynamics*, vol. 37, no. 2, pp. 365– 373, 2014.

10. Recent Professional Development Activities

AIAA Guidance, Navigation and Control Technical Committee, 2017-current

Associate Editor, *AIAA Journal of Guidance, Navigation, and Control*, 01/2016–current

Associate Editor, *IEEE Control Systems Magazine*, 01/2015 – current

Associate Editor, *Frontiers, Space Robotics*, 01/2018-current

Program committee member, 2018 IEEE Conference on Decision and Control

Publicity Chair, IFAC Networked & Autonomous Air & Space Systems (NAASS), Santa Fe, NM, 2018.

11. Other - Consulting

SpaceX, Spaceflight Industries, Amazon Prime, Charles Start Draper Laboratory

1. Name: Robert E. Breidenthal

2. Education

Ph.D., Aeronautics, Caltech, 1979
M.S., Aeronautics, Caltech, 1974
B.S., Aeronautical Engineering, Wichita State University, 1973

3. Academic Experience

- University of Washington (AA), Professor, 1997– Present, full time
- University of Washington (AA), Associate Professor, 1987-1997, full time
- University of Washington (AA), Assistant Professor, 1983-1989, full time
- University of Washington (AA), Research Assistant Professor, 1980-1983 full time
- Caltech (Aeronautics), Postdoc, 1978–1980, full time

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

American Physical Society, member
American Institute of Aeronautics and Astronautics, Associate Fellow

7. Selected Honors and awards

- Donald W. Douglas Fellow, Caltech 1973-1978.
- NSF Fellow, Caltech 1973-1976.
- Professor of the Year, Department of Aeronautics and Astronautics 1994.
- Tan Chin Tuan Visiting Professorship, National Technological University, Singapore 2005.
- Commencement Speaker, AA Department 2006, 2007.
- UW Outstanding Professor nomination 2008
- Fculty Appreciation for Career Education & Training (FACET) award 2019

8. Service Activities

- Fund Review Committee, UW, Chair
- Faculty Council for Benefits and Retirement, UW

9. Publications/Presentations in the Past 5 Years

Fundamentals of turbulent entrainment from simple cartoons of vortices, R.E. Breidenthal, Technical University of Berlin, February 1, 2019.

Fundamentals of turbulent entrainment, R.E. Breidenthal, University of Warsaw, February 5, 2019.

Acceleration effects on turbulent entrainment, R.E. Breidenthal, University of Warsaw, February 5, 2019.

Cloudtop entrainment instability, R.E. Breidenthal, University of Warsaw, February 6, 2019.

Entrainment at a stratified interface, R.E. Breidenthal, University of Warsaw, February 6, 2019.

Environmental concerns in general aviation, R.E. Breidenthal, *Ethical Issues in Aviation, 2nd Ed.*, ed. E.A. Hoppe, 2019.

Study on the effectiveness of plasma induced flow in manipulating a near-wall vortex, T. Wittig, G.F. Nino, & R.E. Breidenthal AIAA Science and Technology Forum and Exposition Sand Diego, Jan. 7, 2019.

Model of the trajectory of an inclined jet in incompressible flow, Y. Feng, Y. Song, & R.E. Breidenthal *AIAA J.* 56 (2), 458-464, 2018.

Trajectory of an inclined jet in incompressible crossflow, R.E. Breidenthal, Y. Feng, & Y. Song, APS Division of Fluid Dynamics Annual Meeting, Denver, November, 2017.

Anatol and Clouds, R.E. Breidenthal, Anatol Roshko Symposium, Caltech, September 16, 2017.

Trajectory of an inclined jet in incompressible crossflow, R.E. Breidenthal, Y. Feng, & Y. Song, Harbin Institute of Technology, Harbin, China, March, 2017.

Sonic eddy model of the turbulent boundary layer, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Acceleration effects on entrainment, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Coulomb repulsion for turbine blade cooling, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Confined jet mixers, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Maximum-drag bluff bodies, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Relaminarization using stationary vortices, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Fundamentals of turbulent entrainment using simple cartoons of vortices, R.E. Breidenthal, Harbin Institute of Technology, Harbin, China, March, 2017.

Sonic eddy model of the turbulent boundary layer, R.E. Breidenthal, P. Dintilhac, & O. Williams, APS Division of Fluid Dynamics Annual Meeting, November, 2016.

Radiation theory of a low NOx combustor and Coulomb repulsion for film cooling of turbine blades, R.E. Breidenthal, I. Krichtafovitch, D. Karkow, & J. Colannino, University of Arizona, 2016.

The effect of Reynolds number on the drag of a rectangular cylinder, R.E. Breidenthal, J. Wai, APS Division of Fluid Dynamics Annual Meeting, Boston, November 22-24, 2015.

Radiative cooling in a flameholder for NOx reduction, R.E. Breidenthal, I. Krichtafovitch, D. Karkow, & J. Colannino, APS Division of Fluid Dynamics Annual Meeting, San Francisco, November 22-24, 2014.

10. Recent Professional Development Activities
Consultant for numerous industrial firms

1. Name: Adam P. Bruckner

2. Education
Ph.D.: Princeton University, 1972
M.A.: Princeton University, 1968
B.Engr.: McGill University, 1966

3. Academic Experience
Professor Emeritus: Nov. 2017-present
Professor: Sept. 1991-Oct. 2017
Department Chair: July 1998-June 2010
Research Professor: July 1988 - Sept. 1991
Research Associate Professor: July 1978 – June 1988
Research Assistant Professor: July 1975 – June 1978
Research Associate: June 1972 – June 1975

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations
American Institute of Aeronautics and Astronautics (AIAA) (Fellow)

7. Selected Honors and awards
AIAA/ASME Best Paper Award in Category of Propulsion, 2016
Undergraduate Instructor of the Year, AA Dept., 2016
Fellow, American Institute of Aeronautics and Astronautics (AIAA), 1997
Certificate of Appreciation, Universities Space Research Association (USRA), 1994
Professor of the Year, AA Dept. (co-recipient), 1994
AIAA Certificate of Recognition, 1992; Certificate of Appreciation, 1991
AIAA Associate Fellow, 1989
Burlington Resources, Inc. Faculty Achievement Award for Outstanding Research, 1989
USRA Distinguished Service Award, 1989
NASA Certificate of Appreciation, 1985, 1986, 1989, 1992
NASA Certificate of Recognition, 1983
AIAA PNW Section Award for Outstanding Contribution to Aerospace Engineering, 1973
British Association Medal, McGill University, 1966

8. Service Activities

- Chair, A&A Undergraduate Program Committee, 2011-2014
- Chair, A&A Space Systems Center Committee, 2005-2014
- Chair, A&A Instructional Laboratory Committee, 1998-2014
- A&A Space Allocation and Utilization Committee, 2009-2014 (Chair, 2009-2012)
- A&A Astronautics Working Group, 2011-2014
- CoE Accreditation and Continuous Improvement Committee, 2012-2013
- CoE Council for Educational Policy, 2011-2014
- Technical Advisory Board, Global Integrated Systems Engineering (GISE) Program, CoE, 2006-2014
- Museum of Flight Spaceflight Committee, 2011- present

9. Publications/Presentations in the Past 5 Years

Igbinosun, O.J., Bruckner, A.P., and Wood, S.E., "In Situ Measurements of Water Content for Sub-Surface Planetary Applications Using Near-Infrared Internal Reflection Spectroscopy (IRS) with a Multimode Optical Fiber," *Applied Spectroscopy*, Aug. 2018. Https://Journals.Sagepub.Com/Doi/10.1177/0003702818781868, Hard Copy in Press.

Knowlen, C., Bauer, P., Bengherbia, T., Yao, Y.F., Bruckner, A.P., and Giraud, M., "Unsteady 1-D Thrust Modeling with EOS Effects for Ram Accelerator Experiments at Different Bores," *Aerotecnica Missili & Spazio: The Journal of Aerospace Science, Technologies and Systems*, 97: 19-26, 2018.

Knowlen, C., Byrd, T., Dumas, J., Daneshvaran, N., Bruckner, A. P., and Higgins A.J., "Baffled Tube Ram Accelerator Combustion," Paper 1117, 26th ICDERS, Boston, MA, July 30-Aug. 4, 2017.

Knowlen, C., Byrd, T., Dumas, J., Daneshvaran, N., Glusman, J.F., Bruckner, A.P., and Higgins. A.J., "Baffled-Tube Ram Accelerator Operation with Inclined Baffles," Paper AIAA 2017-4959, AIAA Propulsion and Energy Forum and Exposition, Atlanta, GA, July 10-12, 2017.

Lee, J.P., and Bruckner, A.P., "Let No New Improvement Pass Us By: The History of the Kirsten-Boeing Engineering Company," Paper AIAA 2017-0114, AIAA SciTech Forum, Grapevine, TX, January 9-13, 2017

Knowlen, C., Glusman, J.F., Grist, R.D., Bruckner, A.P., Higgins A.J., "Experimental Investigation of a Baffled-Tube Ram Accelerator," Paper AIAA 2016-4813, AIAA Propulsion and Energy Forum and Exposition, Salt Lake City, UT, July 25–27, 2016. (Winner of AIAA/ASME Best Paper Award in category of propulsion.)

Bruckner, A.P., and Knowlen, C., "The Ram Accelerator: Review of Experimental Activities in the U.S.," in *Experimental Methods in Shock Wave Research*, Igra, O., and Seiler, F. (eds.), Springer-Verlag, Berlin, Germany, Vol. 10, Ch. 4, Igra, O., and Seiler, F. (eds.), Springer-Verlag, Berlin, Germany, 2016. (Invited).

Bruckner, A.P., Lee, J.P., and Musi, S.M., "The Boeing Aerodynamical Chamber and its Impact on Aeronautics Education at the University of Washington," AIAA-2016-1397, AIAA SciTech Forum, San Diego, CA, Jan. 4-7, 2016. (Invited).

10. Professional development activities

UW College of Engineering ADVANCE Workshops, 2001-2010
Technical conferences and workshops, continuous

11. Other

Five U.S. Patents (Co-Inventor)

1. Name: Dana Dabiri

2. Education

B.S., University of California, San Diego, 1985
M.S. University of California, Berkeley, 1987
Ph.D. Aerospace Engineering University of California, San Diego, 1992

3. Academic Experience

2009-Present:	Associate Professor, Department of Aeronautics and Astronautics, University of Washington
2002-2009:	Assistant Professor, Department of Aeronautics and Astronautics, University of Washington
1999-2002:	Research Scientist, California Institute of Technology
1996-1999:	Senior Research Fellow, California Institute of Technology
1993-1996:	Research Fellow, California Institute of Technology
1992-1993:	Postdoctoral Researcher, University of California, San Diego
1988-1992:	Graduate Student/Research Assistant, University of California, San Diego
1986-1987:	Graduate Student/Research Assistant, University of California, Berkeley
1986:	IBM Corporation, Mechanical Engineer, San Jose

4. Non-Academic Experience

General Pixels, Inc. 6/96-12/01
Arcadia, CA, USA
Co-founder, Developer & Marketer of PixelFlow

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

- American Institute of Aeronautics and Astronautics Associate Fellow 2016-present
- American Institute of Aeronautics and Astronautics Senior Member 2009-present
- American Institute of Aeronautics and Astronautics Member 2002-2009
- American Society of Mechanical Engineers 1992-present
- American Physical Society 1991-present
- American Society of Engineering Education 2003-present

7. Selected Honors and awards

Nominated for Distinguished Teaching Award, 2006, University of Washington
UC Regents Fellowship, 1988 – 1989, University of California, San Diego
Gallery of Fluid Motion Best Poster Award, 1993, Albuquerque, New Mexico

8. Service activities

- AIAA Student Advisor 2009-2013
- Chair Replacement Committee 2010, 2018
- Strategic Planning Committee 2008-2015
- Undergraduate Committee 2002-2010, 2012-2014, 2018
- UWAL Committee 2004-2015
- Faculty Advisor, Sigma Gamma Tau Student Section 2006-2010, 2015-present

- Faculty Search Committee 2010-2015
- Safety Team 2012-2014
- Safety Team Chair 2017-present
- Space Allocation Committee 2012-2014
- College Council 2011-2012, 2017-Present
- ACI Committee 2010-2012
- COE Council on Educational Policy 2005-2008, 2017-2019
- AIAA Aerodynamic Measurement Technology Technical committee5/2016-present
- Associate Editor for *Journal of Visualization* 3/2009-Present
- Organizer (with Professor Aliseda) of the 72th Annual Meeting of the American Physical Society Division of Fluid Dynamics, Seattle, WA, 2019 -present
- Member of the organizational committee for the 12th International Symposium of Particle Image Velocimetry, Busan, Korea, 2017 2016-2017
- Member of the organizational committee for the 11th International Symposium of Particle Image Velocimetry, Santa Barbara, CA, 2015 2014-2015
- Member of the scientific committee for the 16th International Symposium on Flow Visualization (ISFV16), Okinawa, Japan, 2014 2013-2014
- Member of the scientific committee for 13th International Symposium on Particle Image Velocimetry (PIV2019), Munich, Germany 2019
- Member of the organizational committee for the 57th Annual Meeting of the American Physical Society Division of Fluid Dynamics, Seattle, WA, 2004 2003
- Member of the organizational committee for the 6th International Symposium on Particle Image Velocimetry at the California Institute of Technology, Pasadena, CA, 2005-2003

9. Publications/Presentations in the Past 5 Years

1. Paul M., Tien W-H., Dabiri D. (2014) *A displacement-shifted vision-based hybrid particle tracking velocimetry (PTV) technique*, Experiments in Fluids, 55:1676, DOI 10.1007/s00348-014-1676-x
2. Tien W-H., Dabiri D., Hove J.R. (2014) *Color-coded three-dimensional micro particle tracking velocimetry and application to micro backward-facing step flows*, Experiments in Fluids, 55:1684, DOI 10.1007/s00348-014-1684-x

10. Recent Professional Development Activities

Technical conferences

1. Name: Antonino Ferrante

2. Education

Ph.D., Mechanical and Aerospace Engineering, University of California, Irvine, 2004
M.S., Aeronautics and Aerospace (with honors), von Kármán Institute for Fluid Dynamics, Belgium, 1997
B.S., Laurea, Ingegneria Aeronautica (summa cum laude), Università di Napoli 'Federico II', Italy, 1996

3. Academic Experience

University of Washington (AA), Associate Professor, 9/2015-Present
University of Washington (AA), Assistant Professor, 7/2009-8/2015
Sabbatical at Stanford University, Visiting Faculty, Winter 2019
University of Washington (AA), Affiliate Assistant Professor, 8/2008-6/2009
California Institute of Technology (GALCIT), Postdoctoral Scholar, 3/2007-6/2009
University of California, Irvine (MAE), Postdoctoral Scholar , 3/2004-2/2007
University of California, Irvine (MAE), Graduate Research Assistant, 9/1998-2/2004
Università di Napoli 'Federico II', Italy (AE), Research Assistant, 8/1997-8/1998
von Kármán Institute, Belgium (AA), Graduate Research Assistant , 9/1996-6/1997

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

AIAA, APS

7. Selected Honors and awards

2012 ICTAM Travel Fellowship Grant Award, U.S. National Academies of Science (NAS)
2012 Royalty Research Fund Award, University of Washington (UW)
2011 NSF CAREER Award, Office of CyberInfrastructure, Fluid Dynamics, Particulate and Multiphase Processes
2004 Capability Application Project on IBM Power4+, High-Performance Computing Modernization Program, Department of Defense (DoD)
2003 Gallery of Fluid Motion, Video Entry Award, American Physical Society, Division of Fluid Dynamics (APS-DFD)
2003 Dissertation Fellowship Award, Henry Samueli School of Engineering, University of California, Irvine
1998 Study Abroad Fellowship Award, Università di Napoli 'Federico II', Italy
1997 Belgian Government Prize & Diploma with Honors,von Kármán Institute for Fluid Dynamics, Belgium

8. Service activities

- Chair of Undergraduate Committee in the Dept. of Aeronautics & Astronautics, UW
- Diversity Committee & Space Committee in the Dept. of Aeronautics & Astronautics, UW
- Committee chair and member on exams of graduate students
- Panel reviewer for NSF and DoE, RRF (UW) and Swiss Center for Supercomputing
- Scientific Committee of the International Conference of Multiphase Flows
- Organizing Committee of APS Division of Fluid Dynamics Conferences (2017-2019)

- Reviewer for top journals in Fluid Mech. and Comput. Phys., ICMF, ILASS Europe
- Chaired conference sessions at APS, AIAA, ICTAM and ICMF

9. Publications/Presentations in the Past 5 Years

Freund A. & Ferrante A. (2019), "Wavelet-spectral analysis of droplet-laden isotropic turbulence" *J. Fluid Mechanics*, pp. 1-13, *Under Review*

Aithal, A. & Ferrante A. (2019), "A fast pressure-correction method for incompressible flows over curved walls" *J. Comput. Physics*, pp. 1-29, *Under Review*

McCann B.T. & Ferrante A. (2019), "A wall model for large-eddy simulation of compressible channel flows" *Physics Review Fluids*, pp. 1-46, *Under Review*

Dodd M.S. & Ferrante A. (2016), "On the interaction of Taylor lengthscale size droplets and isotropic turbulence" *J. Fluid Mechanics*, Vol. 806, pp. 356-412

Featured article of "Droplets in turbulence: a new perspective" by Prof. M. Maxey in Focus on Fluids of J. Fluid Mechanics, Vol. 816 (2017)

Dodd M.S. & Ferrante A. (2014), "A fast pressure-correction method for incompressible two-fluid flows" *J. Comput. Physics*, Vol. 273, pp. 416–434

Baraldi A., Dodd M.S. & Ferrante A. (2014), "A mass-conserving volume-of-fluid method: volume tracking and droplet surface-tension in incompressible isotropic turbulence" *Computers & Fluids*, Vol. 96, pp. 322-337 | DOI | Google Scholar

ILASS 2019 – Keynote Lecture
Institute of Liquid Atomization and Spray Systems, Tempe, AZ
"Physical mechanisms of droplet/turbulence interaction", May 14, 2019

Lawrence Livermore National Laboratory, Livermore, CA
"Physical mechanisms of droplet/turbulence interaction", February 25, 2019

NASA Ames, Mountain View, CA, Advanced Modeling & Simulation Seminar Series
"A fast pressure-correction method for incompressible flows over curved walls", Feb 22, 2019

Stanford University, Palo Alto, CA, Center for Turbulence Research
"A fast pressure-correction method for incompressible flows over curved walls", Jan 25, 2019

Stanford University, Palo Alto, CA
Dept. of Mechanical Engineering – Fluid Mechanics Seminar Series CoE
"On the physical mechanisms of droplet/turbulence interaction", May 1, 2018

Additional invited talks (2014-17): *University of California, Irvine; University of Southern California; Lawrence Berkeley National Lab; University of California, Berkeley; University of California, Los Angeles; California Institute of Technology; Stanford University.*

Conference presentations (2014-2019): 24 @ *APS-DFD, ICMF, ICNMMF, ICTAM, U.S.-TAM*

10. Recent Professional Development Activities

Sabbatical at the Center for Turbulence Research at Stanford University, Palo Alto, Winter 2019
High-Performance Computing – Artificial Intelligence Conference, Stanford University, 2019

1. Name: James C. Hermanson

2. Education

Ph.D., Aeronautics, California Institute of Technology, 1985
M.S., Aeronautics, California Institute of Technology, 1980
B.S., Aeronautics & Astronautics, University of Washington, 1977

3. Academic Experience

University of Washington (AA), Associate Chair 2009-2010, Chair, 2010-2014

University of Washington (AA), Associate Professor, 2002-2008, Professor, 2008-present

ZARM (Center for Applied Space Technology and Microgravity), Bremen, Germany, Visiting (Fulbright) Professor, 2016-2019

Kungliga Tekniska Högskolan, Stockholm, Department of Mechanics, Visiting Professor, 2015

Stanford University, Aeronautics and Astronautics, Visiting Professor, 2014

Worcester Polytechnic Institute, Mechanical Engineering, Professor, 2002, Associate Professor, 1997-2002, Assistant Professor, 1995-1997

University of Connecticut, Mechanical Engineering, Visiting Associate Professor, 1993

University of Washington (APL), Senior Engineer/Research Assistant Professor, 1986-1988

4. Non-Academic Experience

United Technologies Research Center, East Hartford, CT, 1988-1995

Boeing Aerospace Company, Kent, WA, 1977-1979

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

American Institute of Aeronautics and Astronautics (Associate Fellow)

American Society of Mechanical Engineers (Fellow)

American Physical Society

The Combustion Institute

Christian Engineering Society

7. Selected Honors and awards

Distinguished Educator, Aeronautics & Astronautics, 2019.

Undergraduate Educator of the Year, Aeronautics & Astronautics, 2018.

University of Washington *Distinguished Teaching Award Nominee*, 2013, 2017.

Best Paper Award, *18th Microgravity Science and Space Processing Symposium* (42nd AIAA Aerospace Sciences Meeting), 2004.

ASME Curriculum Innovation Award - Honorable Mention, 2001

Russell M. Searle Instructorship (*Teacher of the Year*), ME/WPI, 2001

George I. Alden Chair in Engineering, WPI, 1999.

8. Service activities

A&A Graduate Committee

College of Engineering Council on Promotion and Tenure (Chair)

9. Publications/Presentations in the Past 5 Years

- Gonzalez, J.C., Allen, J.S., and Hermanson, J.C., "Evolution of Convective Structure and Heat Transfer of Evaporating Films under Cyclic Conditions" *AIAA Journal of Thermophysics and Heat Transfer*, revision submitted, 2019.
- Bellur, K., Hussey, D., Jacobson, D., Lamana, J., Medici, E., Hermanson, J.C., Allen, J.S. and Choi, C.-K., "Neutron attenuation analysis of cryogenic propellants," *J. Heat Transfer-Transactions of the ASME* 140 (3), 030904-1, 2018.
- Bellur, K., Medici, E.F., Hermanson, J.C., Choi C.K., and Allen, J.S., "Determining solid-fluid interface temperature distribution during phase change of cryogenic propellants using transient thermal modeling," *Cryogenics* 91, 103-111, 2018.
- Liao, Y.-H. and Hermanson, J.C., "OH-PLIF Imaging of the Reaction Zone in Swirled, Strongly-Pulsed Jet Diffusion Flames with a Low Reynolds Number," *Combustion Science and Technology* 190 (4), 615-631, 2018.
- Kimball, J., Hermanson, J.C. and Allen, J.S., "Convective Structure Evolution and Heat Transfer in Transient Evaporating Films," *AIAA Journal of Thermophysics and Heat Transfer*, 78, 125105, 2017.
- Albernaz, D.L., Do-Quang, M., Hermanson, J.C. and Amberg, G. "Droplet deformation and heat transfer in isotropic turbulence," *Journal of Fluid Mechanics*, 820, 61-85. 2017.
- Albernaz, D.L., Do-Quang, M., Hermanson, J.C. and Amberg, G. "Real fluids near the critical point in isotropic turbulence," *Physics of Fluids* 28 (12), 125105, 2016.
- Lin, E.P., Kim, Y.-J., and Hermanson, J.C., "The Structure of Compression Waves on Supersonic Droplets," *AIAA Journal* Vol. 54, No. 2, pp. 777-781, 2016.
- Bellur, K., Medici, E.F., Kulshrestha, M., Konduru, V., Tamilarasan, A., McQuillen, J., Leao, J.B., Hussey, D.S., Schershlight, J., Hermanson, J.C., Choi, K.-C., and Allen, J.S., "A new experiment for investigating evaporation and condensation of cryogenic propellants," *Cryogenics* 74, pp. 131-137, 2016.
- Bellur, K., Medici, E.F., Allen, J.S., Choi, K.-C., Hermanson, J.C., Tamilarasan, A., Hussey, D.S., Jacobson, D., Leao, J.B., and McQuillen, J., "Neutron Radiography of Condensation and Evaporation of Hydrogen in a Cryogenic Condition," ***J. Heat Transfer*** 137 (8), 080901, 2015.
- Narendranath, A.D., Hermanson, J.C., Kolkka, R.W., Struthers, A.A. and Allen, J.S., "The Effect of Gravity on the Stability of an Evaporating Liquid Film," *Microgravity Science and Technology* 26 (3), 189-199, 2014.

10. Recent Professional Development Activities

#MeTooSTEM Workshop, "Building Healthy Academic Workplaces," 2019

Campus HR Operations & Services Workshop "Preventing Sexual Harassment," 2018.

Technical conferences

1. Name: Carl Knowlen

2. Education

Ph.D., Aeronautics and Astronautics, University of Washington, 1991
M.S., Aeronautics and Astronautics, University of Washington, 1985
B.S., Aeronautics and Astronautics, University of Washington, 1983

3. Academic Experience

University of Washington, Research Associate Professor, 2015-present
University of Washington, Senior Research Scientist, 2003-2015
University of Washington, Research Scientist, 1996-2003
University of Washington, Research Associate, 1991-1996

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

AIAA (associate fellow)
AIAA Ground Test Technical Committee, 2019-present
AIAA Pressure Gain Technical Committee, 2018-present
SATA representative, 2018-present

7. Selected Honors and awards

Undergraduate Instructor of the Year, W.E.B. Department of Aeronautics & Astronautics, 2017
AIAA Best Paper Award for AIAA 2016-4813, 2016
Highly Rated Course for the College of Engineering, AA462 2014
Highly Rated Course for the College of Engineering, AA462 2012
Highly Rated Course for the College of Engineering, AA312 2012

8. Service activities

Faculty mentor for Society of Advanced Rocket Propulsion student organization, 2011-present

9. Publications/Presentations in the Past 5 Years

Boening, J. A., Wheeler, E. A., Heath, J. D., Koch, J. V., Mattick, A. T., Breidenthal, R. E., Knowlen, C., and Kurosaka, M.,"Rotating Detonation Engine Using a Wave Generator and Controlled Mixing," *Journal of Propulsion and Power*, pp.1–12. doi:10.2514/1b36603, 2018.

Knowlen, C., Bauer, P., Bengherbia, T., Yao, Y., Bruckner, A.P., and Giraud, M., Unsteady 1-D Thrust Modeling with EOS Effects for Ram Accelerator Experiments at Different Bores," *Aerotecnica Missili & Spazio, The J. of Aerospace Science, Technology and Systems*, Vol. 97, Issue 1, pp 19-26, 2018.

Bruckner, A.P. and Knowlen, C., "The Ram Accelerator: Review of Experimental Research Activities in the U.S," *Experimental Methods of Shock Wave Research*, Vol. 9, Igra, O. and Seiler, F. (eds.), Springer-Verlag, Berlin, 79 – 110, 2016 (invited).

Bauer, P., Bengherbia, T., Knowlen, C., Yao, Y., Bruckner, A.P., and Giraud, M., "Equations of State Implementation for 1-D Modelling of Performance in Ram Accelerator Thermally Choked Propulsion Mode," *Int. J. Eng. Syst. Modeling & Simulation*, 7(2):71-79, 2015.

Knowlen, C. and Hudgins, M., "Kirsten Wind Tunnel Flow Quality Assessment: 2018," doi: 10.2514/6.2019-1944, 2019 AIAA SciTech Forum, January 7-11, 2019.

Leege, B.J., Miller, B.F., Pflibsen Jr., T.W., and Knowlen, C., "Design and Analysis of Rocket Ejectors with Experimental and Flight Test Validation," doi: 10.2514/6.2019-1682,2019 AIAA SciTech Forum, January 7-11, 2019.

Koch, J.V., Washington, M.R., Kurosaka, M., and Knowlen, C., "Operating Characteristics of a CH4/O2 Rotating Detonation," doi: 10.2514/6.2019-0475, 2019 AIAA SciTech Forum, January 7-11, 2019.

Wheeler, E., Knowlen, C., and Kurosaka, M., "Thrusting Pressure and Supersonic Exhaust Velocity in a Rotating Detonation Engine," AIAA 2018-0884, 2018.

Knowlen, C., Daneshvaran, N., Byrd, T., Dumas, J., "Computational Fluid Dynamic Modeling of Baffled Tube Ram Accelerator Experiments," doi: 10.2514/6.2018-1417, AIAA SciTech Forum, Kissimmee, FL, January 8–12, 2018.

Knowlen, C. and Kurosaka, M., "Orderly Wave Initiation in a Rotating Detonation Engine" ICDERS Paper 2017-1088, presented 26th Internati Knowlen, C. and Mitsuro, M., "Orderly Wave Initiation in a Rotating Detonation Engine," 26th International Colloquium on the Dynamics of Explosions and Reactive Systems, Boston, MA, July 30 – August 4, 2017.

Knowlen, C., Byrd, T., Dumas, J., "Daneshvaran, N., Bruckner, A.P., & Higgins, A.J., "Baffled Tube Ram Accelerator Combustion Effects," 26th International Colloquium on the Dynamics of Explosions and Reactive Systems, Boston, MA, July 30 – August 4, 2017.

Bauer,P., Bengherbia,T., Yao,Y., Knowlen, C., Bruckner, A.P., and Giraud, M., "Ram Accelerator Thrust Modeling for Different Bores," Italian Association of Aeronautics and Astronautics, XXIV Int'l Conference, 18-22 September 2017, Palermo–Enna, Italy.

Derk, G., Kimber, A., Grist, R., Knowlen, C., Shah, G., & Sawhill, S., "Optimization of Combustion Efficiency in an AF-M315E Fine Droplet Injection Microthruster," AIAA 2017-4994, ITAR Session, 2017 AIAA Propulsion and Energy Forum, Atlanta, GA, July 10-12, 2017.

Knowlen, C., Byrd, T., Dumas, J., Daneshvaran, N., Glusman, J., Grist, R., Bruckner, A.P., & Higgins, A.J., "Baffled-Tube Ram Accelerator Operation with Inclined Baffles," AIAA 2017-4959, 2017 AIAA Propulsion and Energy Forum, Atlanta GA, July 10-12, 2017.

Daneshvaran, N. and Knowlen, C., "Transient Computational Fluid Dynamic Modeling of Baffled Tube Ram Accelerator," AIAA 2017-0119, 2018 AIAA SciTech Forum, Grapevine, TX, January 9-13, 2017.

Grist, G., Knowlen, C., Shah, G., & Sawhill, S., "Experimental Investigation of Fine Droplet Injectors on AF-M315E Microthruster Operation," AIAA 2016-5075, ITAR Session, 2016 AIAA Propulsion and Energy Forum, Salt Lake City, UT, July 25-27, 2016.

Knowlen, C., Glusman, J., Grist, R., Bruckner, A.P., & Higgins, A.J., "Experimental Investigation of a Baffled-Tube Ram Accelerator," AIAA 2016-4813 (AIAA Best Paper Award), 2016 AIAA Propulsion and Energy Forum, Salt Lake City, UT, July 25-27, 2016.

Kurosaka, M., Knowlen, C., and Boening, J.A. "Theoretical and Experimental Consideration of the Continuous Rotating Detonation Engine," AIAA Paper 2016-4967, 2016.

10. Recent Professional Development Activities
Rotating detonation engine AFOSR technical meetings, journal referee, SATA participation

1. Name: Mitsuru Kurosaka

2. Education
Ph.D., Mechanical Engineering, California Institute of Technology, 1968
M.S., Mechanical Engineering, University of Tokyo, 1961
B.S., Naval Architecture, University of Tokyo, 1959

3. Academic Experience
University of Washington, Professor, 1987-present
L'ecole Nationale Supérieure de Mécanique et d'Aérotecnique, Visiting Professor, 2007
University of Tennessee Space Institute, Professor, 1979-1987
Massachusetts Institute of Technology, Visiting Professor, 1984-1985
University of Tennessee Space Institute, Associate Professor, 1977-1979

3. Non-Academic Experience
Fluid Mechanics Engineer, General Electric Research and Development Center, 1969-1977
Engineering Specialist, AiResearch Manufacturing Company, 1967-1969
Thermal Design Engineer, Hitachi Ltd., Tokyo, 1961-1963

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations
AIAA (associate fellow)
ASME (fellow)
Japan Gas Turbine Society (member)

7. Selected Honors and awards
Professor of Year, Department of Aeronautics and Astronautics 1993
AIAA General H.H.(Hap) Arnold Award 1983

8. Service activities
- Peer review committee (chair)
- Faculty Senate representative

9. Publications/Presentations in the Past 5 Years

Kurosaka, M., and Tsuboi, N., "Spinning detonation, cross-currents, and the Chapman–Jouguet velocity," *Journal of FluidMechanics*, Vol. 756, 2014, pp. 728–757. doi:10.1017/jfm.2014.460.

Boening, J. A., Wheeler, E. A., Heath, J. D., Koch, J. V., Mattick, A. T., Breidenthal, R. E., Knowlen, C., and Kurosaka, M.,"Rotating Detonation Engine Using a Wave Generator and Controlled Mixing," *Journal of Propulsion and Power*, 2018, pp.1–12. doi:10.2514/1.b36603.

Boening, J.A., Heath, J.D., Byrd, T.J., Koch, J.V., Mattick, A.T., Breidenthal, R.E., Knowlen, C. and Kurosaka, M., "Design and Experiments of a Continuous Rotating Detonation Engine: a Spinning Wave Generator and Modulated Fuel-Oxidizer Mixing," AIAA Paper 2016-4966.

Kurosaka, M., Knowlen, C., and Boening, J.A. "Theoretical and Experimental Consideration of the Continuous Rotating Detonation Engine," AIAA Paper 2016-4967.

Koch, J.V., Washington, M.R., Kurosaka, M, and Knowlen, C., “Operating Characteristics of a CH4/O2 Rotating Detonation Engine in a Backpressure Controlled Facility,” AIAA 2019-0475.

Wheeler, E., Knowlen, C., and Kurosaka, M., “Thrusting Pressure and Supersonic Exhaust Velocity in a Rotating Detonation Engine,” AIAA 2018-***0884***.

Knowlen, C. and Kurosaka, M., “Orderly Wave Initiation in a Rotating Detonation Engine” ICDERS Paper 2017-1088, presented 26th International Colloquim on the Dynamics of Explosions and Reactive Systems, July 30, Boston, MA.

10. Recent Professional Development Activities

Rotating detonation engine conferences, journal referees

1. Name: Justin Little

2. Education
Ph.D., Mechanical and Aerospace Engineering, Princeton University, 2015
B.S., Physics, University of California Irvine, 2008
B.S., Aerospace Engineering, University of California Irvine, 2008

3. Academic Experience
University of Washington, Assistant Professor, 2018-present, full-time
University of Washington, Lecturer, 2016-2018, part-time
University of Washington, Research Scientist, 2016-2018, part-time

4. Non-Academic Experience
MSNW LLC, Principal Research Scientist, 2016-2017, part-time
MSNW LLC, Research Scientist, 2015-2016, full-time

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations
American Society for Engineering Education, 2018 – present
American Institute of Aeronautics and Astronautics, 2009 – present
Electric Rocket Propulsion Society, 2008 – present

7. Selected Honors and awards
Plasma Science and Technology Fellowship, 2010-2012, Princeton Plasma Physics Laboratory
National Defense Science and Engineering Graduate Fellowship, 2009-2011, AFOSR
Summa Cum Laude, 2008, University of California, Irvine
Phi Beta Kappa, 2008, Phi Beta Kappa Society

8. Service activities
- Member, AIAA Electric Propulsion Technical Committee, 2019-present
- Mentor for *NSF – Washington State Academic RedShirt (STARS)*, 2019
- Faculty Technical Lead – UW A&A CubeSat Team, 2018-2019
- Co-Organizer, "The Next Step for In-Space Propulsion," Special Session Panel, *AIAA Propulsion and Energy Forum*, Indianapolis, IN, 2019
- Co-Organizer, "Young Visionary in Electric Propulsion," Paper Competition, *35th International Electric Propulsion Conference*, Atlanta, GA, 2017

9. Publications/Presentations in the Past 5 Years

C. L. Kelly and J. M. Little, "Energy and Mass Utilization during Drag-Modulated Plasma Aerocapture." 40th IEEE Aerospace Conference, Big Sky, MT, 2.0312, 2019.

C. L. Promislow[1], A. J. Sheppard[1], and J. M. Little, "Time-resolved electron beam fluorescence for measuring neutral particles in EP plasmas." 35th International Electric Propulsion Conference, Atlanta, GA, IEPC Paper 2017-30. 2017.

S. Hepner, T. Collard, J. M. Little, and B. Jorns, "Low-frequency plasma oscillations in the plume of a low temperature magnetic nozzle." 35th International Electric Propulsion Conference, Atlanta, GA, IEPC Paper 2017-515. 2017.

J. M. Little and E. Y. Choueiri, "Electron Cooling in a Magnetically Expanding Plasma." Physical Review Letters, 117, 225003, 2016.

J. M. Little and E. Y. Choueiri, "Critical Condition for Plasma Confinement in the Source of Magnetic Nozzle Flows." IEEE Transactions on Plasma Science: Special Issue on Plasma Propulsion, PP, 99, 2015.

A. Pancotti, J. M. Little, J. Neuhoff, B. Cornella, D. Kirtley, J. Slough, "Electrodeless Lorentz Force (ELF) Thruster for ISRU and Sample Return Missions." 34th International Electric Propulsion Conference, Kobe, Japan, IEPC Paper 2015-67. 2015.

L. Ferrario, J. M. Little and E. Y. Choueiri, "Propulsive Performance of a Finite-Temperature Plasma Flow in a Magnetic Nozzle with Applied Azimuthal Current." Physics of Plasmas, 21, 113507. 2014

J. M. Little and E. Y. Choueiri, "Influence of the Applied Magnetic Field Strength on Flow Collimation in Magnetic Nozzles." Proceedings of 50th Joint Propulsion Conference, Cleveland, OH, AIAA Paper. No. 2014-3912. 2014.

L. Ferrario, J. M. Little and E. Y. Choueiri, "Experimental Verification of Plasma Focusing by Azimuthal Current in a Magnetic Nozzle." Proceedings of 50th Joint Propulsion Conference, Cleveland, OH, AIAA Paper. No. 2014-4026. 2014.

J. M. Little and E. Y. Choueiri, "Thrust and Efficiency Model for Electron-Driven Magnetic Nozzles." Physics of Plasmas, 20, 103501. 2013.

J.M. Little and E. Y. Choueiri, "Plasma Transport in a Converging Magnetic Field with Applications to Helicon Plasma Thrusters." 33rd International Electric Propulsion Conference, Washington, DC, IEPC Paper 2013-125. 2013.

J. M. Little and E. Y. Choueiri, "Electric Propulsion System Scaling for Asteroid Capture-and-Return Missions." Proceedings of 49th Joint Propulsion Conference, San Jose, CA, AIAA Paper. No. 2013-4125. 2013.

10. Recent Professional Development Activities

Technical conferences and workshops
Journal article reviewer
Proposal reviewer

1. Name: Eli Livne

2. Education

Ph.D., Aerospace Engineering, University of California, Los Angeles, 1990
M.S., Aeronautical Engineering, Technion, Israel Institute of Technology, 1982
High School Teaching Credential, Technion, Israel Institute of Technology, 1974
B.S., Aeronautical Engineering, Technion, Israel Institute of Technology, 1974

3. Academic Experience

University of Washington (AA), Professor, 2002-present
University of Washington (AA), Associate Professor, 1996-2002
University of Washington (AA), Assistant Professor, 1996-2002
University of California, Los Angeles, Postdoctoral Research Fellow, 1990

4. Non-Academic Experience

Israeli Air Force, R&D Department, Head of the Dynamics & Aeroelasticity Group, 1975-1984.

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

AIAA(Fellow), ASME

7. Selected Honors and awards

AIAA – Fellow
The ASME/Boeing Structures & Materials Award, April 1998, for the best paper (out of more than 400 papers) "which was judged to be an outstanding contribution to the engineering profession and was given at the 38th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics and Materials Conference", April 1997.
NSF National Young Investigator Award, 1992-1997.
UCLA School of Engineering and Applied Science Outstanding Ph.D. 1989-90.
1987-1988 Josephine de Karman Fellowship.
1984 - 85, 85 - 86, 86 - 87, 87 - 88, 88 - 89, 89 - 90 UCLA Fellowships.
Valedictorian - Department of Aeronautical Engineering, Technion, Israel, 1974.

8. Service activities

- Chair, Faculty Search Committee (for a number of years), 2013 – 2016
- Department Associate Chair for Research and Infrastructure
- Chair, Department Space Allocations Committee
- Director of UW AER Labs
- AA Strategic Planning Committee (past)
- AA Undergraduate Committee (past)
- College of Engineering endowed professorships committee
- AIAA – Editor in Chief of the Journal of Aircraft

9. Publications/Presentations in the Past 5 Years

- Jackson, T., and Livne, E., "Integrated Aeroservoelastic Design Optimization of Actively-Controlled Strain-Actuated Flight Vehicles", AIAA Journal, 2014, volume 52, No. 6, pp. 1105-1123, doi: 10.2514/1.J050941
- Chen, P.C., Zhang, Z., and Livne, E., "Design Oriented Computational Fluid Dynamics Based Unsteady Aerodynamics for Flight Vehicle Shape Optimization", AIAA Journal, 2015, Vol. 53, No. 12, pp. 3603-3619. doi: 10.2514/1.J054024.
- Wu, S., and Livne, E., "Probabilistic Aeroservoelastic Reliability Assessment Considering Control System Component Uncertainty", AIAA Journal, 2016, Vol.54, pp. 2507-2520, doi: 10.2514/1.J054824
- Langston, S, Nelson, C.P., and Livne, E., "Low-Speed Stability and Control of a Reduced Scale Long-Range Supersonic Configuration with Reduced-Size or No Vertical Tail", AIAA Paper 2016-1036, AIAA SciTech2016 Conference, San Diego, CA January 2016, doi: 10.2514/6.2016-1036
- Liu, Y., Bai, J., and Livne, E., "Robust Optimization of Variable-Camber Continuous Trailing-Edge Flap Static Aeroelastic Action", AIAA Journal, 2017, Vol.55, pp. 1031-1043, doi: 10.2514/1.J055054
- Wu, S., and Livne, E., "Alternative Aerodynamic Uncertainty Modeling Approaches for Flutter Reliability Analysis", AIAA Journal, 2017, Vol.55, pp. 2808-2823, doi: 10.2514/1.J055334
- Precup N., Mundt, T., Mor, M., and Livne, E., "An Active Variable Camber Continuous Trailing Edge Flapped Wing Wind Tunnel Model for Aeroelastic ‘‘In-Flight‘‘ Shape Optimization Tests", AIAA Paper 2018-3106, AIAA Aviation 2018 Forum, Atlanta, GA, June 2018, doi: 10.2514/6.2018-3106
- Livne, E, "Aircraft Active Flutter Suppression: State of the Art and Technology Maturation Needs", Journal of Aircraft, Vol. 55, No. 1, Jan.-Feb. 2018, pp. 410-452, doi: 10.2514/1.C034442, (41 pages)
- Ricci, S., Fonte, F., De Gaspari, A., Riccobene, L., Mantegazza, P., Toffol, F., and Livne, E., "Development of a Wind Tunnel Model for Active Flutter Suppression Studies", AIAA Paper 2019-2029, AIAA Scitech 2019 Forum, 2019, doi:10.2514/6.2019-2029
- Quenzer, J., Zongolowicz, A., Hinson, K.A., Barzgaran, B., Livne, E., Mesbahi, M., and Morgansen, K., "Model for Aeroelastic Response to Gust Excitation", AIAA 2019-2031, AIAA Scitech 2019 Forum, 2019, doi: 10.2514/6.2019-2031

10. Recent Professional Development Activities

Technical conferences and workshops

Engineering consulting to a number of companies, including, in the past, Boeing, Andrews Space, Blue Origin, Stirling Dynamics, Inc.

Continued development of the UW's large-team capstone airplane design program.

1. Name: Christopher W. Lum

2. Education

Ph.D., Aeronautics & Astronautics, University of Washington, Seattle, WA 2009
M.S., Aeronautics & Astronautics, University of Washington, Seattle, WA 2005
B.S., Aeronautics & Astronautics, University of Washington, Seattle, WA 2003

3. Academic Experience

University of Washington (AA), Research Assistant Professor 2016-Present
Research Scientist 2011–2016
Lecturer 2007–2016
Post-Doctoral Research Associate 2009–2010
Research Assistant 2004–2009
Teaching Assistant 2003-2004

Visiting Fellow, Queensland University of Technology, Brisbane, Australia 2014 - 2015

Adjunct Professor, Seattle University, Seattle 2009 - 2010

4. Non-Academic Experience

14 CFR Part 107 Remote Pilot Certificate, Federal Aviation Administration 2016 – Present

Board of Directors, Association for Unmanned Vehicle Systems International Cascade Chapter, Seattle, WA 2016 – 2018

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

American Institute of Aeronautics and Astronautics (AIAA), 2001 - 2013
Association for Unmanned Vehicle Systems International (AUVSI), 2005 – present
Institute of Electrical and Electronics Engineers (IEEE), 2007 –2008.
Sigma Gamma Tau, 2002 – present.

7. Selected Honors and awards

- Instructor of the Year, 2013, William E. Boeing Department of Aeronautics & Astronautics
- College of Engineering's List of Highly Rated Instructors, 2012, University of Washington
- Instructor of the Year, 2012, William E. Boeing Department of Aeronautics & Astronautics
- College of Engineering's List of Highly Rated Instructors, 2011, University of Washington
- Best Student Technical Paper Award, 2009, American Institute of Aeronautics and Astronautics

8. Service Activities

- International Programs Committee – William E. Boeing Department of Aeronautics & Astronautics (2016 – present)
- Diversity Committee - Department of Aeronautics & Astronautics (2015 – present)
- Engineering Discovery Days Organizer –(2015 – present)

9. Publications/Presentations in the Past 5 Years

- C. W. Lum, H. Rotta, R. Patel, H. Kuni, T. Patana-anake, J. Longhurst, and K. Chen, "UAS Operations and Navigation in GPS-Denied Environments Using Multilateration of Aviation Transponders," *Proceedings of the AIAA SciTech 2019 Forum*, San Diego, CA, 2019.
- A. Bernard, G. Sciuchetti, C. Lynch, A. Sherpa, J. Reiter, and C. W. Lum, "Artificial Light Detection as a Method for Poacher Detection from an Unmanned Aerial Vehicle," *Proceedings of the AIAA SciTech 2019 Forum*, San Diego, CA, 2019.
- Z. Rotter, L. Smit, B. Zhu, K. Taylor, T. Leighton, and C. W. Lum, "Design and Development of a Self-Contained Trailing Static Pressure Measurement System Prototype," *Proceedings of the AIAA SciTech 2019 Forum*, San Diego, CA, 2019.
- N. Sandhu, M. R. Soltani, M. B. Bragg, C. W. Lum, B. S. Woodard, A. P. Broeren, S. Lee, "Effect of Simulated Scalloped Ice on the Aerodynamics of a Swept-Wing at Low-Reynolds Number," *Proceedings of the 2018 Atmospheric and Space Environments Conference*, Atlanta, GA, June 2018.
- S. Lee, A. P. Broeren, B. S. Woodard, C. W. Lum, and T. G. Smith, "Comparison of Iced Aerodynamic Measurements on Swept Wing from Two Wind Tunnels," *Proceedings of the 2018 Atmospheric and Space Environments Conference*, Atlanta, GA, June 2018.
- B. S. Woodard, A. P. Broeren, S. Lee, C. W. Lum, and M. B. Bragg, "Summary of Ice Shape Geometric Fidelity Studies on an Iced Swept Wing," *Proceedings of the 2018 Atmospheric and Space Environments Conference*, Atlanta, GA, June 2018.
- A. P. Broeren, S. Lee, B. S. Woodard, C. W. Lum, T. G. Smith, "Independent Effects of Reynolds and Mach Numbers on the Aerodynamics of an Iced Swept Wing," *Proceedings of the 2018 Atmospheric and Space Environments Conference*, Atlanta, GA, June 2018.
- Z. Caratao, K. Gabel, A. Arun, B. Myers, D. Swartzendruber and C. W. Lum, "MicaSense Aerial Pointing and Stabilization System: Dampening In-Flight Vibrations for Improved Agricultural Imaging," *Proceedings to the AIAA Information Systems-AIAA Infotech@ Aerospace Conference*, Kissimmee, FL, 2018.
- A. Jadon, Z. Williams, C. Kafka, H. Rotta, S. Roy and C. W. Lum, "A Database System Architecture for Air-to-Ground UAS Link Characterization," *Proceedings to the AIAA Information Systems-AIAA Infotech@ Aerospace Conference*, Kissimmee, FL, 2018.
- R. S. Larson, J. Winde, C. W. Lum, "UAS Position Estimation in GPS-Degraded and Denied Environments Via ADS-B and Multilateration Fusion," *Proceedings to the AIAA Information Systems-AIAA Infotech@ Aerospace Conference*, January 2018.
- C. W. Lum, R. Grimes, D. Tsukada, J. Winde and T. Kosel, "Visual Anchoring: Orbiting a Target with a UAS Using Vision as the Primary Sensor Modality," *Proceedings to the AIAA Information Systems-AIAA Infotech@ Aerospace Conference*, Kissimmee, FL, 2018.

10. Recent Professional Development Activities

1. Name: Mehran Mesbahi

2. Education

University of Southern California, Los Angeles	Elect. Engineering, Ph.D.	1996
University of Southern California, Los Angeles	Mathematics, M.S.	1995
University of Southern California, Los Angeles	Elect. Engineering, M.S.	1991
California State University, Northridge	Elect. Engineering Summa cum laude	1989

3. Academic Experience

Endowed University Professorship	Control Systems and Networks	2017–
Adjunct Professor	Dept. of Electrical Engineering, UW	2014–
Executive Director	Joint Center for Aerospace Tech. Innovation	2013–
Professor	Dept. of Aeronautics & Astronautics, UW	2010–
Adjunct Professor	Dept. of Mathematics, UW	2010–
Associate Professor	Dept. of Aeronautics & Astronautics, UW	2005-2010
Assistant Professor	Dept. of Aero. & Astro., UW	2002-2005
Assistant Professor	Dept. of Aerospace Eng. & Mechanics, UMN	2000-2002
Member of Technical Staff	Jet Propulsion Laboratory	1996-1999
Visiting Scholar	California Institute of Technology	1998-1999
Lecturer	University of Southern California	1997-1998

4. Non-Academic Experience

Member of Technical Staff, Jet Propulsion Laboratory
California Institute of Technology 7/1996-1/2000

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

IEEE (Fellow), AIAA (Associate Fellow)

7. Selected Honors and awards

University Professorship in Control Systems and Network, 2017
Fellow of IEEE, Class of 2015
Graduate Instructor of the Year, Department of Aeronautics and Astronautics, UW, 2015
Professor of the Year, Department of Aeronautics and Astronautics, UW (2004, 2006, 2008, 2010)
Innovator Award, College of Engineering, UW, 2008
Distinguished Teaching Award, UW, 2005
NASA Space Act Award, National Aeronautics and Space Administration, 2005
NASA New Technology Award, 2004
NSF CAREER Award, National Science Foundation, Arlington, VA, March 2001-2006

8. Service Activities

Chair, Graduate Committee 2016-present
Faculty Co-Advisor: UW Cubesat Project 2018-present
Member, Faculty Search Committee 2010-2016
Member, Space Allocation Committee 2014-2016
Member, Undergraduate Committee 2012-2015

Member, Diversity Committee 2008-present
Joint Center for Aerospace Technology Innovation, Executive Director, 2013-present
Faculty Fellows Program/Teaching Academy, 2005-present

9. Publications/Presentations in the Past 5 Years (selected)

- T. Reynolds, M. Mesbahi, Coupled 6-DOF Control for Distributed Aerospace Systems, *IEEE Conference on Decision and Control*, 2018.
- T. Reynold and M. Mesbahi, Small Body Precision Landing via Convex Model Predictive Control, *AIAA SPACE and Astronautics Forum and Exposition*, 2017.
- U. Lee, T. Reynolds, B. Katona, B. Barzgaran, and M. Mesbahi, Development of Attitude Determination and Control Subsystem for 3U CubeSat with Electric Propulsion, *AIAA SPACE and Astronautics Forum and Exposition*, 2017.
- M. Hudoba de Badyn, S. Alemzadeh, and M. Mesbahi, Controllability and Data-Driven Identification of Bipartite Consensus on Nonlinear Signed Networks, *IEEE Conference on Decision and Control*, 2017.
- Awad, A. Chapman, E. Schoof, A. Narang-Siddarth, and M. Mesbahi, Time-scale Separation in Networks: State-dependent Graphs and Consensus Tracking, *IEEE Transactions on Control of Network Systems, 2018* (Early Access).
- Y. Yu, B. Acikmese, and M. Mesbahi, Bregman Parallel Direction Method of Multipliers for Distributed Optimization via Mirror Markov Mixing, *IEEE Control Systems Letters* (2) 2: 302 - 306, 2018.
- C. Sun, R. Dai, and M. Mesbahi, Weighted Network Design with Cardinality Constraints via Alternating Direction Method of Multipliers, *IEEE Transactions on Control of Network Systems, 2018* (Early access).
- E. Schoof, A. Chapman and M. Mesbahi, Weighted Bearing-Compass Dynamics: Edge and Leader Selection, *Transactions on Network Science and Engineering,* 2017 (Early access).
- M. Fazel, R. Ge, S. M. Kakade, and M. Mesbahi, Global Convergence of Policy Gradient Methods for the Linear Quadratic Regulator, *International Conference on Machine Learning (ICML)*, 2018.
- S. Mousavi, M. Haeri, and M. Mesbahi, On the Structural and Strong Structural Controllability of Undirected Networks, *IEEE Transactions on Automatic Control, 2017* (Early access).
- A. Alaeddini, K. Morgansen, and M. Mesbahi, Adaptive Communication Networks with Privacy Guarantees, *American Control Conference*, 2017.

10. Recent Professional Development Activities

Regular attendance at Technical conferences and workshops
Engineering consulting to a number of companies including Boeing and Scientific Systems, Inc.
Continued development of the UW's Cubesat Program
Creating a new research track in the department for machine learning and control, and electric aviation

1. Name: Kristi A. Morgansen-Hill

2. Education

Ph.D., Engineering Sciences, Harvard University, 1999
S.M., Applied Mathematics, Harvard University, 1996
M.S., Mechanical Engineering, Boston University, 1994
B.S., Mechanical Engineering (summa cum laude), Boston University, 1993

3. Academic Experience

University of Washington (AA), Professor, 2015-present
University of Washington (AA), Associate Professor, 2009-2015
University of Washington (AA), Associate Professor, 2002-2009
California Institute of Technology, Senior Research Fellow, Control and Dynamical Systems and Mech. Eng. 2001-2002
California Institute of Technology, Postdoctoral Scholar, Control and Dynamical Systems and Mech. Eng. 1999-2001
California Institute of Technology, Lecturer, Control and Dynamical Systems, 2000

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

American Institute of Aeronautics and Astronautics
American Society of Engineering Educators
Institute of Electrical and Electronic Engineers (senior member 2006)

7. Selected Honors and awards

UW Aeronautics & Astronautics Graduate Educator of the Year Award, 2018.
Defense Sciences Study Group, 2018-2019.
University of Washington Leadership Excellence Program, 2016-2017.
Associate Fellow, 2016, American Institute of Aeronautics and Astronautics.
American Institute of Aeronautics and Astronautics (AIAA) 2013-2014 PNW Section Educator of the Year, June 2014, AIAA.
O. Hugo Schuck Award for best paper in the theory category for the 2009 American Control Conference.
Senior Member, 2006, Institute of Electrical and Electronic Engineers.
National Science Foundation CAREER Award, 2003-2009, National Science Foundation.
Clare Boothe Luce Assistant Professor of Engineering, 2002-2007, The Luce Foundation.

8. Service activities

- A&A Chair 2019 – present
- A&A Interim Chair 2018-2019
- *AIAA Aerospace Department Chairs Association* 2018 – present
- *AIAA Higher Education Committee* 2018 – present
- *2021 American Control Conference, Program Chair* 2018-2021
- *AIAA Pacific Northwest Section Council Member* 2016-2018

- *IEEE Transactions on Control System Technology*, Associate Editor 2014-2018
- A&A Associate Chair for Academics 2015-2018
- Graduate School Council, College of Engineering representative 2015-2018
- University of Washington Diversity Council 2014-2015
- IEEE Control System Society Board of Governors 2012-2014

9. Publications/Presentations in the Past 5 Years

- J. Quenzer and K. A. Morgansen, "Robustness of quadratic stability guarantees for multi-controller systems," *AIAA Journal of Guidance, Control and Dynamics,* in preparation (March 2019).
- N. Powel and K. A. Morgansen, "Empirical observability Gramian for stochastic observability of nonlinear systems," *IEEE Transactions on Automatic Control*, in revision.
- A. Alaeddini, M. Mesbahi and K. A. Morgansen, "Optimal control with limited sensing via empirical Gramians and piecewise linear feedback," *Systems and Control Letters*, in revision.
- T. Avant and K. A. Morgansen, "Characterization of image-based local pose quality using empirical observability," *American Control Conference*, July 2019, to appear.
- J. Quenzer, A. Zongolowicz, K. Hinson, B. Barzgaran, E. Livne, M. Mesbahi, and K. A. Morgansen, "Model for Aeroelastic Response to Gust Excitation," *AIAA Science and Technology Forum and Exposition*, January 2019.
- B. Katona and K. A. Morgansen, "Navigation of Indoor Spaces Using Multiple Quadrotors," *AIAA Science and Technology Forum and Exposition*, January 2019.
- T. Avant, U. Lee, B. Katona, and K. A. Morgansen, "Dynamics, Hover Configurations, and Rotor Failure Restabilization of a Morphing Quadrotor," *American Control Conference*, June 2018.
- N. L. Brace, T. L. Hedrick, D. H. Theriault, N. W. Fuller, Z. Wu, M. Betke, J. K. Parrish, D. Grünbaum, and K. A. Morgansen, "Using collision cones to assess biological deconfliction methods," *Proceedings of the Royal Society: Interface*, 13(122), September 2016.
- A. Alaeddini and K. A. Morgansen, "Bio-inspired navigation for a nonholonomic mobile robot," *Journal of Aerospace Information Systems*, 12(12):688-698, special issue, December 2015.
- B. T. Hinson and K. A. Morgansen, "Gyroscopic sensing in the wings of the hawkmoth *Manduca sexta*: The role of sensor location and directional sensitivity," *Bioinspiration & Biomimetics*, 10(5), October 2015.
- B. T. Hinson and K. A. Morgansen, "Observability-based optimal sensor placement for flapping airfoil wake," *AIAA Journal of Guidance, Control and Dynamics*, 37(5):1477-1486, 2014.
- F. van Breugel, K. A. Morgansen and M. Dickinson, "Monocular distance estimation from optic flow during active landing maneuvers," *Bioinspiration & Biomimetics*, special issue, 9(2):025002 (9 pages), 2014.

10. Recent Professional Development Activities

Technical conferences and workshops
Proposal review panels

1. Name: Susan Murphy

2. Education
M.S.: City University, 2003
B.A.: Northeastern Illinois University, 1981

3. Academic Experience
Affiliate Associate Professor: Sept. 2008-present

4. Non-Academic Experience
Senior Project Manager and Project Management Instructor, Boeing, BCA Production Engineering, 2015-2019
Senior Project Manager, Boeing, 787 Airplane Level Integration Team, 2010-2015
Senior Project Manager, Boeing, 787 Wiring Integration, 2008-2010
Senior Project Manager, Boeing, 787 Customer Introductions, 2007-2010
Senior Project Manager, Boeing, CATIA V4-45 Information Technology Transition, 2006-2007
Senior Project Manager, Boeing, 787 Remote Product Definition / Split Bridge, 2004-2006
Senior Project Manager, Boeing, CAD/CAM Products and Services, 1997-2003
Project Manager, Boeing, Distributed Computing Support Services, 1997-1997
Project Manager, Boeing, Aerodynamics, 1995-1996
Project Management and Systems Development Life Cycle Contractor to Boeing, DMR, 1993-1995
Project Manager, Software Analyst and Developer, Sears Roebuck & Co, 1981-1993

5. Certifications or Professional Registrations
Project Management Professional (Project Management Institute): April 2004 - present

6. Memberships in Professional Organizations
Project Management Institute (PMI): April 2004 - present

7. Selected Honors and awards
Boeing Cash Awards: 2018, 2011, 2010, 2009, 2008, 2004, 2003, 1998
Boeing Stock Awards: 2004, 2002, 2001, 1998
Boeing Stock Option Awards: 1998
Numerous Pride @ Boeing Awards & Boeing Instant Recognition Awards
2016 New Group Instructor Excellence Award, Ed Wells Partnership (Joint SPEEA/Boeing Initiative)

8. Service activities
Project Management lecture: UW/Boeing ALVA Internship Program, yearly since 2015
Project Management Workshop: UW A&A Capstone Program, December 2018
Project Management Workshop: UW Bio Engineering Capstone Program, 2016 & 2017

9. Publication/presentations of the Past 5 Years

10. Recent Professional Development Activities
Continuing Education seminars to maintain Project Management Professional (PMP)

1. Name: Marco Salviato

2. Education

Ph.D., University of Padova, Padova, Italy (Theoretical and Applied Mechanics) 2013
M.S., University of Padova, Padova, Italy (Summa cum laude, Mechanical Engineering) 2009
B.S., University of Padova, Padova, Italy (Summa cum laude, Mechanical Engineering) 2007

3. Academic Experience

University of Washington, Assistant Professor, Aeronautics & Astronautics 2015–Present
Adjunct Assistant Professor, Materials Science and Engineering 2019–Present

Northwestern University, Evanston, IL, Research Assistant Professor, Civil & Environmental Engineering 2014–2015
Postdoctoral Scholar, Civil & Environmental Engineering 2013–2014

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

- EMI – Engineering Mechanics Institute (2013 - present)
- ASME – American Society of Mechanical Engineers (2013 - present)
- ASC – American Society for Composites (2013 - present)

7. Selected Honors and awards

- Faculty Appreciation for Career Education & Training (FACET) award, *University of Washington*, (2019)
- Haythornthwaite Young Investigator Award, *American Society for Mechanical Engineering.*, Citation: "for excellence in theoretical and applied mechanics", (2017)
- Best Graduate Educator, *University of Washington – Department of Aeronautics and Astronautics*, (2017)
- Juniores Prize, *Italian Association for Strain Analysis (IASA*) for the best conference paper by a single author 35 years old and younger, (2012)
- InTesi Award, *Chamber of Commerce of Padova* for innovative master thesis in mechanical engineering, (2009)
- M.S. Gold Medal, *University of Padova* for best graduate in the College of Engineering, (2009)
- B.Sc. Gold Medal, *University of Padova* for best undergraduate in the College of Engineering, (2007)
- College of Engineering Fellowship, *University of Padova*, (2004-2009)

8. Service activities

- Diversity committee (2018 – present)
- Graduate committee (2015 – present)
- MSE faculty search committee 2017 – 2018)
- Member, Computer Committee 2003-2005

9. Publications/Presentations in the Past 5 Years (selected)

- Carloni C., Cusatis G., Salviato M., Le J., Hoover C., Bažant Z.P., Critical Comparison of X. Hu et al.'s Boundary Element Method with Cohesive Crack Model and Size Effect Law, *Engineering Fracture Mechanics*, 215,193-210, (2019).
- Salviato M., Kirane K., Bažant Z.P., Cusatis G. Mode I and II Interlaminar Failure in Laminated Composites: A Size Effect Study, *Journal of Applied Mechanics*, In press.
- Ko S., Davey J., Douglass S., Yang J., Tuttle M.E., Salviato M., Effect of the Thickness on the Fracturing Behavior of Discontinuous Fiber Composite Structures, *Composites Part A*, In press.
- Qiao Y., Salviato M., Study of the Fracturing Behavior of Thermoset Polymer Nanocomposites via Cohesive Zone Modeling, *Composite Structures*, 220, 127-147, (2019).
- Qiao Y., Salviato M., Strength and Cohesive Behavior of Thermoset Polymers at the Microscale: A Size-Effect Study, *Engineering Fracture Mechanics*, 213, 100-117, (2019).
- 8. Salviato M., Phenisee E.S., Enhancing the Electrical and Thermal Conductivities of Polymer Composites via Curvilinear Fibers: An Analytical Study, *Mathematics and Mechanics of Solids*, In press.
- 9. Zappalorto M. , Maragoni M., Salviato M., Exact solution for the mode III stress fields ahead of rounded notches. *Fatigue and Fracture of Materials and Structures*, 42, 612-626, (2019).
- 10. Salviato M., Zappalorto M. , Maragoni L., Exact solution for the mode III stress fields ahead of cracks initiated at sharp notch tips, *European Journal of Solids A*, 72, 88-96, (2018).
- 11. Mefford H.C., Qiao Y., Salviato M., Failure and Scaling of Graphene Nanocomposites, *Composite Structures*, 176:961-972, (2017).
- 12. Jin C , Salviato M., Li W. , Cusatis G. Elastic Microplane Formulation for Transversely Isotropic Materials. *ASME Journal of Applied Mechanics*, 84(1) 011001, (2017).
- 13. Salviato M., Zappalorto M. A Unified Solution Approach for a Large Variety of Anti-Plane Shear and Torsion Notch Problems: Theory and Examples. *International Journal of Solids and Structures*, 102-103:10-20 (2016).
- 15. Salviato M., Chau V.T. , Li W. , Bažant Z.P. , Cusatis G. Direct Testing of Gradual Postpeak Softening of Fracture Specimens of Fiber Composites Stabilized by Enhanced Grip Stiffness and Mass. *ASME Journal of Applied Mechanics*, 83 (11), 111003, (2016).
- 16. Salviato M., S. E. Ashari, Cusatis G. A Spectral Stiffness Microplane Model for Damage and Fracture of Textile Composites. *Composite Structures*; 137:170-184, (2016).
- 18. Kirane K., Salviato M., Bažant Z.P. Hierarchical multiscale microplane model for fracturing behavior of woven composites. *ASME Journal of Applied Mechanics*, 83:0410061-14 (2016).
- 19. Kirane K., Salviato M., Bažant Z.P. Multiscale Microplane Model for Predicting Elastic Properties of Woven Fabric Composites. *Journal of Composite Materials*, 50:1247-1260 (2016)
- 20. Su Y. , Bažant Z.P. , Zhao Y. , Salviato M, Kirane K. Viscous energy dissipation of kinetic energy of particles comminuted by high-rate shearing in projectile penetration, with potential ramification to gas shale. *International Journal of Fracture*; 193:77-85, (2015).
- 21. Bažant Z.P., Salviato M., Chau V.T., Viswanathan H., Zubelewicz A. Why Fracking Works. *Journal of Applied Mechanics*, 81,101010-1-10, (2014).

10. Recent Professional Development Activities

1. Name: Uri Shumlak

2. Education
Ph.D., Nuclear Engineering, University of California, Berkeley, 1992
B.S., Nuclear Engineering, Texas A & M University, 1987

3. Academic Experience

University of Washington, Professor:	2007 – present
University of Washington, Associate Chair for Research:	2015 –2018
University of Washington, Acting Chair:	2015 –2016
University of Washington, Associate Chair for Research:	2010 –2013
University of Washington, Associate Professor:	2002 –2007
University of Washington, Assistant Professor:	1999 –2002
University of Washington, Research Assistant Professor:	1994 –1999

4. Non-Academic Experience

Lawrence Livermore National Lab, Faculty Scholar:	2018 –2019
Lawrence Livermore National Lab, Visiting Scientist:	2016 – 2018
Air Force Research Lab, National Research Council Fellow:	1992 – 1994

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations
American Institute of Aeronautics and Astronautics
American Physical Society
Institute of Electrical and Electronics Engineers
Society for Industrial and Applied Mathematics
University Fusion Association

7. Selected Honors and awards
Weizmann Institute of Science, Erna and Jakob Michael Visiting Professorship, 2018
Lawrence Livermore National Laboratory, Faculty Scholar, 2018
American Institute of Aeronautics & Astronautics Associate Fellow, 2016
University of Washington Aeronautics & Astronautics Graduate Educator of the Year, 2016
University Fusion Association (UFA), President, 2015-2016.
University of Washington College of Engineering Faculty Innovator Award, 2011
American Institute of Aeronautics and Astronautics Abe Zarem Award of Excellence, 2003
University of Washington Aeronautics & Astronautics Professor of the Year, 2002
American Institute of Aeronautics & Astronautics Senior Member, 2001
University of Washington Aeronautics & Astronautics Professor of the Year, 1999
National Research Council Postdoctoral Fellowship, 1992

8. Service Activities
IEEE International Conference on Plasma Science Technical Chair
DOE Office of Science Strategic Planning Program Committee
ASME Propulsion Technical Committee
International Conference on the Numerical Simulation of Plasma Program Committee
International Program Advisory Committee for Innovative Fusion Approaches

9. Publications/Presentations in the Past 5 Years

- Y. Zhang, U. Shumlak, B.A. Nelson, R.P. Golingo, T.R. Weber, A.D. Stepanov, E.L. Claveau, E.G. Forbes, Z.T. Draper, J.M. Mitrani, H.S. McLean, K.K. Tummel, D.P. Higginson, and C.M. Cooper. Sustained Neutron Production from a Sheared-Flow Stabilized *Z* Pinch. *Physical Review Letters* 122, 135001 (2019).
- A. Ho, I.A.M. Datta, and U. Shumlak. Physics-Based-Adaptive Plasma Model for High-Fidelity Numerical Simulations. *Frontiers in Physics* 6, 105 (2018).
- G.V. Vogman, U. Shumlak, and P. Colella. Conservative fourth-order finite-volume Vlasov-Poisson solver for axisymmetric plasmas in cylindrical (*r*, *vr*, *v*q) phase space coordinates. *Journal of Computational Physics* 373, 877 (2018).
- U. Shumlak, B.A. Nelson, E.L. Claveau, E.G. Forbes, R.P. Golingo, M.C. Hughes, R.J. Oberto, M.P. Ross, and T.R. Weber. Increasing plasma parameters using sheared flow stabilization of a Z-pinch. *Physics of Plasmas* 24, 055702 (2017).
- M.P. Ross and U. Shumlak. Digital holographic interferometry employing Fresnel transform reconstruction for the study of flow shear stabilized Z-pinch plasmas. *Review of Scientific Instruments* 87 (10), 103502 (2016).
- E.M. Sousa and U. Shumlak. A blended continuous – discontinuous finite element method for solving the multi-fluid plasma model. *Journal of Computational Physics* 326, 56 (2016).
- S.T. Miller and U. Shumlak. A multi-species 13-moment model for moderately collisional plasmas. *Physics of Plasmas* 23 (8), 082303 (2016).
- E.M. Sousa, G. Lin, and U. Shumlak. Uncertainty quantification of the GEM challenge magnetic reconnection problem using the multilevel Monte Carlo method. *International Journal for Uncertainty Quantification* 5 (4), 327 (2015).
- S.D. Knecht, R.P. Golingo, B.A. Nelson, and U. Shumlak. Calculation of the equilibrium evolution of the ZaP Flow Z-Pinch using a four-chord interferometer. *IEEE Transactions on Plasma Science* 43 (8), 2469 (2015).
- S.D. Knecht, W. Lowrie, and U. Shumlak. Effects of a conducting wall on Z-pinch stability. *IEEE Transactions on Plasma Science* 42 (6), 1531 (2014).
- G.V. Vogman, P. Colella, and U. Shumlak. Dory-Guest-Harris instability as a benchmark for continuum kinetic Vlasov-Poisson simulations of magnetized plasmas. *Journal of Computational Physics* 277, 101 (2014).
- E. Kansa, U. Shumlak, and S. Tsynkov. Discrete Calderon's Projections on Parallelepipeds and their Application to Computing Exterior Magnetic Fields for FRC Plasmas. *Journal of Computational Physics* 234,172 (2013).

10. Recent Professional Development Activities

Weizmann Institute of Science, Erna and Jakob Michael Visiting Professorship, 2018
Lawrence Livermore National Laboratory, Faculty Scholar, 2018
American Institute of Aeronautics & Astronautics Associate Fellow, 2016
University Fusion Association (UFA), President, 2015-2016.
National Research Council Postdoctoral Fellowship, 1992

1. Name: Owen J.H. Williams

2. Education

Ph.D., Mechanical and Aerospace Engineering, Princeton, 2014
MEng (Hons), Aeronautic Engineering, Imperial College, 2008

3. Academic Experience

University of Washington (AA), Research Assistant Professor, 2016-present
University of Maryland (AA), Post-doctoral scholar, 2015
Princeton University (MAE), McGraw Teaching Fellow, 2012
Princeton University (MAE), Graduate Research Assistant, 2008-2014

4. Non-Academic Experience

5. Certifications or Professional Registrations

6. Memberships in Professional Organizations

AIAA, APS

7. Selected Honors and awards

2019 Recognized by UW FACET program for positive impact on student career and professional development.

2017 eScience Incubator Program, eScience, University of Washington

2013 Wu Prize for Excellence in research, School of Applied Sciences, Princeton University

2010 Crocco Teaching Award, MAE Department, Princeton University

2008 Princeton First Year Fellowship, Graduate School, Princeton University

2008 Finsbury Medal, Top of Class, Dept. of Aeronautics, Imperial College, UK

2008 E-On Prize for Energy, Energy Futures Lab, Imperial College, UK

2007 Third Year Excellence Award, Department of Aeronautics, Imperial College, UK

2007 Aeronautics Centenary Prize, Department of Aeronautics, Imperial College, UK

8. Service Activities

- Reviewer for six top journals in fluid mechanics and turbulence
- Reviewer for NSERC (Canada)
- UW AA 3x3 wind tunnel manager
- Member of UW AA wind tunnel committee
- STARs program faculty advisor

9. Publications/Presentations in the Past 5 Years

A. Snortland, B. Polagye, H. Ross, and O. Williams. "Influence of near-blade hydrodynamics on cross-flow turbine performance". *EWTEC 2019*, Submitted.

A-M. Schreyer, D. Sahoo, O. Williams, and A.J. Smits. “Experimental investigation of two hypersonic shock turbulent boundary layer interactions”. *AIAA Journal*, 56(12):4830–4844, 2018.

O. Williams. (keynote), “The effects of stable stratification on turbulent boundary layers”. *Okanagan Fluid Dynamics Meeting*, 2017

O. Williams, D. Sahoo, M.L. Baumgartner, and A.J. Smits. “Experiments on the structure and scaling of hypersonic turbulent boundary layers”. *Journal of Fluid Mechanics*, 834:237–270, 2017

O. Williams, T. Hohman, T. Van Buren, E. Bou-Zeid, and A.J. Smits. “Experimental study of the effect of stable thermal stratification on turbulent boundary layer statistics”. *Journal of Fluid Mechanics*, 812:1039–1075, 2017.

O. Williams and A.J. Smits. “Effect of trip size on mean velocity profiles of a hypersonic turbulent boundary layer”. *AIAA Journal*, 55(9):3051–3058, 2017.

T. Van Buren, O. Williams, and A.J. Smits. “Experimental investigation of a thermally stable stratified boundary layer subject to a step change in wall temperature”. *Journal of Fluid Mechanics*, 811:569–581, 2017.

O. Williams and M. Wong. “Evaluating the use of partial orthogonal decomposition (POD) for the separation of turbulent boundary layer structure and unsteady surface-wave forcing”. *Tenth International Symposium on Turbulence and Shear Flow Phenomena (TSFP10),* Chicago, 2017.

O. Williams, C. Helm, and P. Martin. “Examination of uniform momentum zones in hypersonic turbulent boundary layers”. *APS DFD, 2017*

M. Wong and O. Williams. “Structure of turbulent boundary layers subjected to wave forcing”. *APS DFD*.

O. Williams. “Experimental investigation of the interaction between turbulent boundary layers and near-surface wave-induced forcing”. *APS DFD, 2016*.

O. Williams, T. Nguyen, A.-M. Schreyer, and A.J. Smits. “Particle response analysis for particle image velocimetry in supersonic flows”. *Physics of Fluids*, 27, 2015.

O. Williams, T. Van Buren, and A.J. Smits. “A new method for measuring turbulent heat fluxes using PIV and fast-response cold-wires”. *Experiments in Fluids*, 56(7):1–10, 2015.

10. Recent professional development activities

“eScience Incubator Program”, eScience Institute, University of Washington, 2017

Tomographic PIV & Shake-the-box 4D PTV One-day workshop, LaVision Inc., 2017

1. Name: Jinkyu Yang

2. Education

Ph.D., Aeronautics & Astronautics, Stanford University, Stanford, CA 2005

M.S., Aeronautics & Astronautics, Stanford University, Stanford, CA 2001

B.S., Honors, Aerospace Engineering, KAIST, Daejon, Korea 2000

3. Academic Experience

University of Washington, Associate Professor, Aeronautics and Astronautics 2018– present
Assistant Professor, Aeronautics and Astronautics 2013–2018

University of South Carolina, Columbia, SC, Assistant Professor, Department of Mechanical Engineering 2011–2013
Interim Program Director, Aerospace Program 2012–2012

California Institute of Technology, Pasadena, CA, Postdoctoral Scholar, Graduate Aerospace Laboratories 2009 –2011

4. Non-Academic Experience

Samsung Electronics Co., Suwon, Korea, Senior Engineer, R&D 2006 –2009

5. Certifications or Professional Registrations

6. Membership in Professional Organizations

- AIAA – American Institute of Aeronautics and Astronautics (2013 ~ lifetime member)
- ASME – American Society of Mechanical Engineers (2009 ~)
  : Member of Modeling, Dynamics and Control of Adaptive Systems Technical Committee
  Member of Structural Acoustic Committee, Noise Control and Acoustics Division (NCAD)
  Member of Technical Committee on Sound and Vibration (TCSV)
- SEM – Society of Experimental Mechanics (2013 ~ lifetime membership)
- SPIE – International Society for Optics and Photonics (2002, 2004, 2009 ~ lifetime member)

7. Selected Honors and awards

- Hangai Prize, *Best Paper Award by the International Association for Shell and Spatial Structures* (2017).
- Faculty Early Career Development (CAREER) Award, *National Science Foundation* (2016)
- Samsung Think Tank Team Award, one of two inaugural recipients from Samsung Research America (2014)
- Best Paper Award, 7th World Congress on BAMN (Biomimetics, Artificial Muscles and Nano-Bio) Conference (2013)
- Breakthrough Rising Star Faculty Award, University of South Carolina (2013)
- Editors' Choice for the Best Paper of the Year, Journal of Biomechanical Engineering, American Society of Mechanical Engineers (2012)

8. Service Activities

- Safety committee (Spring, 2017 – present)
- Undergraduate committee (Spring, 2017 – present)

- Chair search committee (Fall, 2018 – Winter, 2019)
- A&A Representative, Council on Educational Policy (4/2018 – present)

9. Publication/presentations in the Past 5 Years (selected)

- H. Yasuda, Y. Miyazawa, E.G. Charalampidis, C. Chong, P.G. Kevrekidis, J. Yang, "Origami-based impact mitigation by creating solitary waves with overtaking behavior," arXiv:1805.05909 (under final revision in *Science Advances*).
- R. Chaunsali, C. Chen, J. Yang, "Experimental demonstration of topological waveguiding in elastic plates with local resonators," *New Journal of Physics*, 20: 113036 (2018).
- E. Kim, A. Martinez, S. Phenisee, P.G. Kevrekidis, M. Porter, J. Yang, "Direct measurement of superdiffusive and subdiffusive energy transport in disordered granular chains," *Nature Communications*, 9: 640, 2018.
- H. Yasuda, T. Tachi, M. Lee, J. Yang, "Origami-based tunable truss structures for non-volatile mechanical memory operation," *Nature Communications* 8: 962, 2017.
- R. Chaunsali, E. Kim, A. Thakkar, P.G. Kevrekidis, J. Yang, "Demonstrating an in-situ topological band transition in cylindrical granular chains," *Physical Review Letters*, 119: 024301, 2017.
- H. Kim, E. Kim, C. Chong, P.G. Kevrekidis, J. Yang, "Demonstration of dispersive rarefaction shocks in hollow elliptical cylinder chains," *Physical Review Letters*, 120 (19): 194101, 2018.
- Y. Wu, R. Chaunsali, H. Yasuda, K. Yu, J. Yang, "Dial-in topological metamaterials based on bistable Stewart Platform," *Scientific Reports*, 8:112, 2018.
- H. Yasuda, J. Yang, "Reentrant origami-based metamaterials with negative Poisson's ratio and bistability," *Physical Review Letters*, 114: 185502, **2015.**
- E. Kim, F. Li, C. Chong, G. Theocharis, J. Yang, P.G. Kevrekidis, "Highly nonlinear wave propagation in elastic woodpile periodic structures,**"** Physical Review Letters, 114: 118002, 2015**.**
- F. Li, P. Anzel, J. Yang**,** P.G. Kevrekidis, C. Daraio, "Granular acoustic switches and logic elements,**"** Nature Communications, 5: 5311, 2014.

10. Recent Professional Development Activities

- Mentor and advisor, Bridge to Doctorate (BD) program, PNW LSAMP (scheduled, 2019)
- Technical conferences

APPENDIX C – EQUIPMENT

In this Appendix the experimental facilities and equipment used in the program's undergraduate instruction are listed. Also listed is the Aeronautics & Astronautics Machine Shop, which supports the program.

Aerodynamics Laboratory

In 1916, William E. Boeing saw the need for a wind tunnel to test advanced models of his Model C floatplane, which he intended to sell to the U.S. military. Boeing offered to pay for a wind tunnel at UW in exchange for a promise by the University to establish courses in aeronautics. This wind tunnel, in its original form, was operational from 1918 through 1938, when the modern Kirsten Wind Tunnel came on line. The modified original wind tunnel in the Aerodynamics Lab Building was replaced in the early 1990s with a modern 3'x3' wind tunnel. This facility provides a high-quality, low-turbulence flow at speeds up to 140 mph, and is used for instruction, as well as research. This facility is also available for independent student projects. The tunnel now features a new sign-out system for equipment and facilities, with student access to force/moment measurement, flow visualization, pressure measurement and propeller testing equipment.

Figure C.1 Students working at the 3'x3' Wind Tunnel

Kirsten Wind Tunnel

The Boeing Company, the Washington State Legislature, and the Works Progress Administration allocated funds for the construction of a 8'x12' wind tunnel and building, which was completed in 1936 and came online in 1938 following extensive shake-down testing. In the early 1950s the wind tunnel was named the Kirsten Wind Tunnel, in honor of Frederick W. Kirsten, the faculty member whose tireless efforts led to the construction of the tunnel. After nearly being shut down for lack of business in 1994, the Kirsten Wind Tunnel bounced back, and ever since then has had a months-long waiting list of diverse companies wanting to carry out aerodynamic testing in this very high quality facility. The Kirsten Wind Tunnel continues to be a premier facility for low-speed testing. The tunnel employs a student crew numbering 8–14, which provides them with excellent hands-on training, as well as paid employment, both during the academic year and the summer. The facility is also a key component of our airplane design sequence (AA 410/411), in which students test their designs to determine stability characteristics as well as validate performance parameters. In addition, it is used for several experiments in AA 321, Aerospace Laboratory I. A few times each year the tunnel is involved in independent student research projects that culminate in graduate theses or undergraduate reports. The facility is also used by faculty in sponsored research programs. Finally, The Kirsten Wind Tunnel has also been used by students participating in the annual AIAA Design, Build, Fly (DBF) and Society for Advanced Rocket Propulsion (SARP) competitions.

Fig. C.2 Kirsten Wind Tunnel test section with AA 410/411 model and students.

Water Tunnel and Supersonic Wind Tunnel

A large water tunnel having a test section with cross-section of 2 ft x 2 ft and a length of 6 ft, and capable of a flow speed of 1 m/sec, is located in the Harris Hydraulics Laboratory on the UW campus. This test facility was constructed in-house in the 1980s, and has been used for flow-visualization experiments in instruction and research, as well as for commercial testing. For its instructional purposes, the water tunnel has been used for scheduled experiments in the junior-level Aerospace Laboratory sequence, as well as for independent student projects. Diagnostic tools include a dye injection system (for both colored and fluorescent dyes) and an argon-laser light-sheet illumination system for the fluorescent dyes.

A small, blow-down, supersonic wind tunnel, capable of attaining a Mach number of 2.2 for durations up to 30-40 sec, and having a test section cross-section of 2”x2”, is also located in the Fluid Dynamics Laboratory, and is used for both instructional and research purposes. This tunnel is equipped with a schlieren/shadowgraph optical visualization system, as well as with pressure and temperature transducers. This tunnel is fed by compressed air generated and stored in large, high-pressure tanks in the basement of the Kirsten Wind Tunnel building. A large water tunnel having a test section with cross-section of 2 ft x 2 ft and a length of 8 ft, and capable of a flow speed of 1 m/sec, located in Harris Hydraulics laboratory and shared with members of Mechanical and Civil Engineering Departments. This facility is optimized for high flow speeds and testing of renewable energy devices such as cross-flow. Diagnostic equipment includes dye flow visualization and acoustic Doppler velocimetry (ADV).

A small, blow-down, supersonic wind tunnel, capable of attaining a Mach number of 2.5 for durations up to 30-40 sec, and having a test section cross-section of 2”x2”, is undergoing redesign and is to be located in Guggenheim Hall Room 114. As with its previous incarnation, it will be used for both instructional and research purposes. The new facility will feature a new, waveless nozzle, imaging and laser access ports, as well as particle seeing apparatus that allow for detailed visualization of supersonic flow fields. The tunnel is also equipped with a schlieren/shadowgraph optical visualization system, as well as with pressure and temperature transducers. This tunnel is fed by compressed air generated and stored in large, high-pressure tanks in the basement of the Kirsten Wind Tunnel building.

Other Equipment

Other equipment used for instructional purposes is listed in the tables below

Table C.1 List of equipment in Aerospace Laboratory supporting junior-level lab classes (AA 320, 321. 322); located in Guggenheim 205

Quantity	Description
	Aerospace Laboratory with 10 seats (GUG 205)
10	Oscilloscopes
10	Arbitrary function generators
10	Triple output variable DC power supplies
6	KEPCO 4 Quadrant Power Supply (4 Large, 2 Small)
20	Digital multimeters
5	DC Motor systems
4	Dynamic signal analyzers
4	Beam vibration test rig and associated supplies

Machine Shop

The Department of Aeronautics & Astronautics has a modern, well-equipped machine shop that supports our instructional and research needs. The shop features three CNC machines, a variety of manually-operated lathes and milling machines, a band saw, reciprocating saw, sheet metal brake, press, and all the supporting accessories and tools, as well as a full complement of hand tools. The shop is managed by a Research Scientist/Engineer – Instrument Maker, who teaches classes on machine shop basics and safety to our students.

APPENDIX D – INSTITUTIONAL SUMMARY

1. The Institution

a. Name and address of the institution:
   University of Washington, Seattle, WA 98195

b. Chief executive officer of the institution:
   Ana Mari Cauce, President

c. Self-study report submitted by:
   James C. Hermanson, Professor, William E. Boeing Department of Aeronautics & Astronautics

   J. Edward Connery, Director, Academic Services, William E. Boeing Department of Aeronautics & Astronautics

   Stanley Choi, Undergraduate Program Advisor, William E. Boeing Department of Aeronautics & Astronautics

d. Institution (University of Washington) is accredited by:

   - Northwest Commission on Colleges and Universities (NWCCU)

   - Initial accreditation – 1918

   - Most recent accreditation evaluation – Accreditation was reaffirmed in January 2014, after a comprehensive self-evaluation report and site visit in autumn 2013.

2. Type of Control

State-assisted Public Research University

3. Educational Unit

The Aeronautics & Astronautics Engineering Program is administered by the William E. Boeing Department of Aeronautics & Astronautics which is an academic unit within the College of Engineering. The College of Engineering is a separately organized unit with its own budgetary and program control within the University of Washington. The chair of the William E. Boeing Department of Aeronautics & Astronautics is Kristi Morgansen. Professor Morgansen reports to the Dean of the College of Engineering, Mike Bragg (Note: Dean Bragg will be stepping down from the Dean position effective June 30, 2019). Dean Bragg reports to the Provost and Executive Vice President, Mark Richards. University of Washington and College of Engineering organizational charts are provided in Figures D-1 and D-2.

Figure D-1 University of Washington Organization Chart

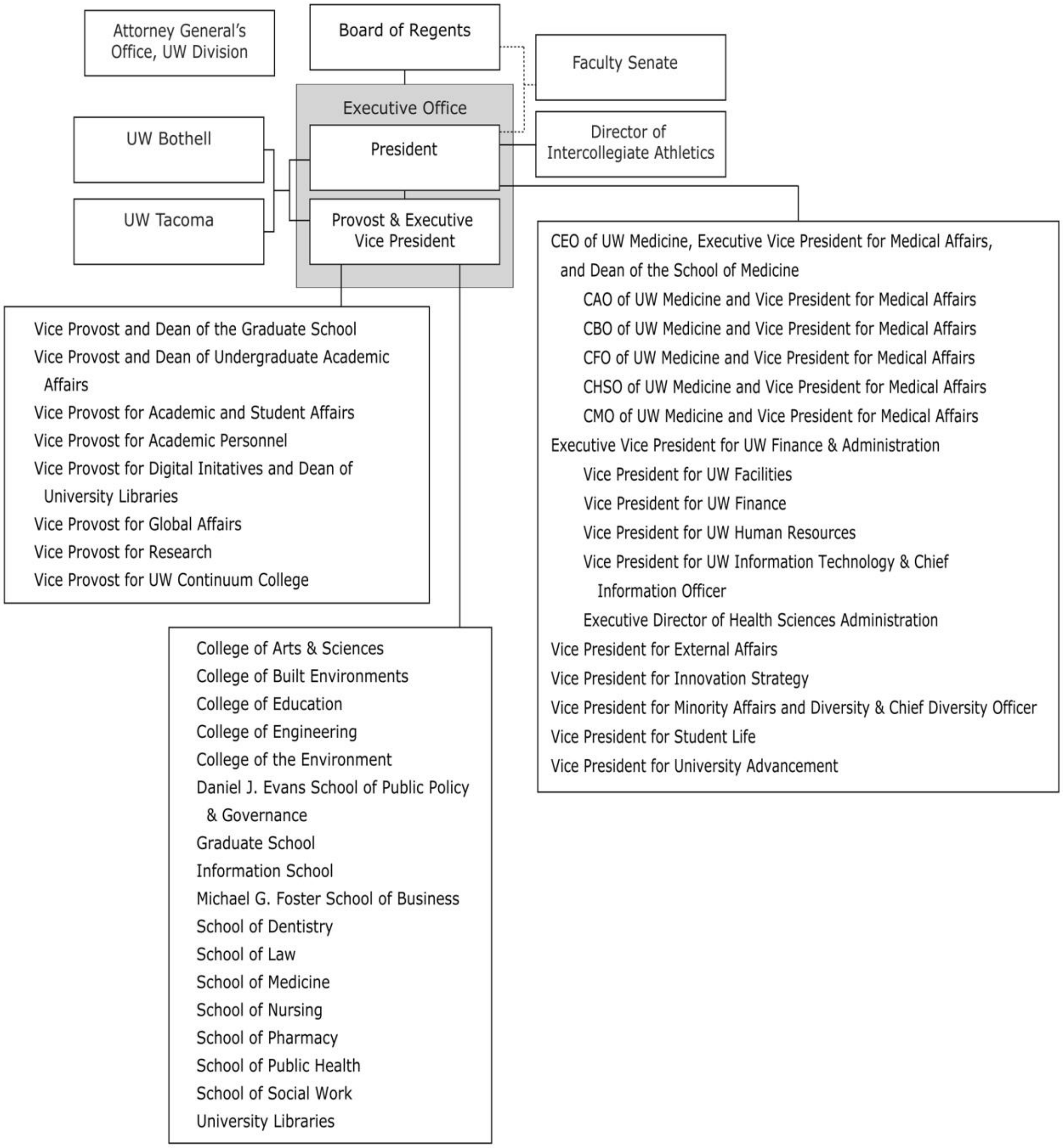
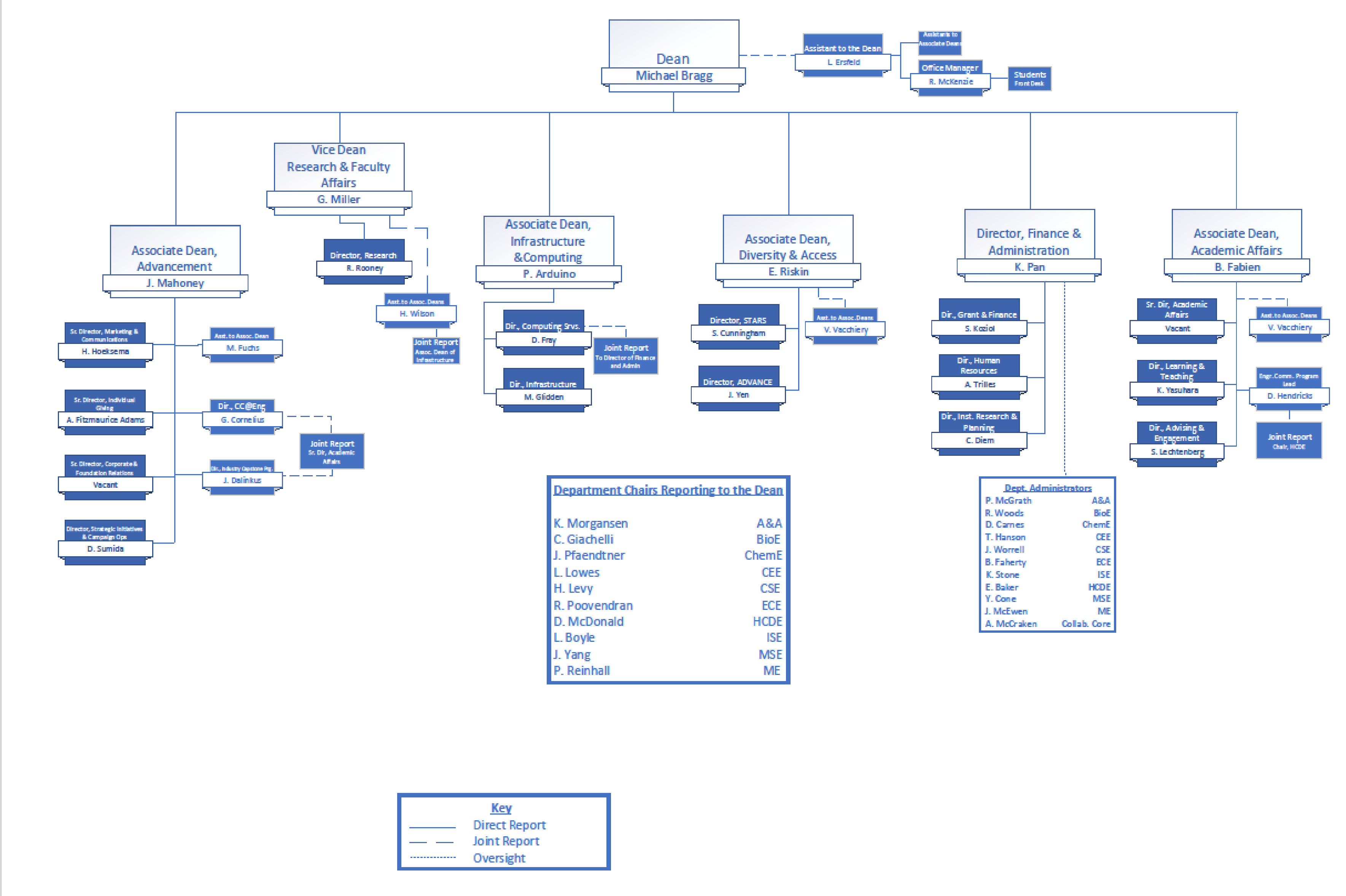


Figure D-2 College of Engineering Organization Chart



4. Academic Support Units

The names and titles of the individuals responsible for the units that teach courses required by the program are provided below.

Unit	Head
Applied Mathematics	Bernard Deconinck, Professor and Chair
Biology	H.D. 'Toby' Bradshaw, Professor and Chair
Chemistry	Michael Heinekey, Professor and Chair
English	Anis Bawarshi, Professor and Chair
Mathematics	John Palmieri, Professor and Chair
Physics	Blayne Heckel, Professor and Chair
Statistics	Thomas Richardson, Professor and Chair

5. Non-academic Support Units

The names and titles of the individuals responsible for each of the units that provide non-academic support to the program being evaluated, e.g., library, computing facilities, placement, tutoring, etc. are provided below.

Unit	Head
UW Enrollment Management	Philip Ballinger, Associate Vice Provost
UW Registrar	Helen Garrett, University Registrar and Chief Officer for Enrollment Information Services
UW Information Technology	Aaron Powell, Vice President for UW Information Technology and Chief Information Officer
UW Libraries	Lizabeth (Betsy) Wilson, Vice Provost for Digital Initiatives and Dean of University Libraries
UW Office of Minority Affairs & Diversity	Rickey Hall, Vice President for Minority Affairs & Diversity
College of Engineering Academic Affairs	Brian Fabien, Professor and Associate Dean
Engineering, Learning, & Teaching	Jim Borgford-Parnell, Director
College of Engineering Office of Diversity & Access	Eve Riskin, Professor and Associate Dean
College of Engineering Computing Services	David Fray, Director
Career Center @ Engineering	Gail Cornelius, Director
Engineering Library	Mel DeSart, Head, Engineering Library
UW Office of First Year Programs	LeAnne Jones Wiles, Director
UW ADVANCE Center for Institutional Change	Eve Riskin, Faculty Director

6. Credit Unit

The University of Washington operates on a quarter system. The standard academic year consists of three 10-week quarter terms. Each quarter also includes a final exam week. For a traditional lecture-based class, one quarter credit normally represents one class hour and two hours of work outside of class per week. Contact hours include different formats including laboratories, quiz session, and tutorial sessions. Depending on the expectation for work outside of class, one quarter credit normally represents two to three hours of lab, quiz, or tutorial per week. Considering the diversity of teaching styles and learning environments, the University and the College of Engineering curriculum committees will consider approving courses that vary from the standard guidelines. For such courses, faculty must present written justification for the departure from the standard course credit/contact hour ratios.

7. Tables

Table D-1. Program Enrollment and Degree Data

Aeronautics & Astronautics Engineering

Academic Year		Enrollment Year					Total Undergrad	Total Grad	Degrees Awarded		
		1st	2nd	3rd	4th	5th			Bachelors	Masters	Doctorates
2018-2019	FT	0	17	70	91	1	179	112	Data will be available mid-July		
	PT				7		7	112			
2017-2018	FT	13	19	66	99	3	200	113	75	55	7
	PT				2		2	121			
2016-2017	FT	18	27	78	95	4	222	102	72	78	5
	PT			2	1	1	4	136			
2015-2016	FT	9	15	55	77	2	158	101	60	61	10
	PT			7	2	1	10	141			
2014-2015	FT	3	11	54	73	1	142	91	58	43	6
	PT							140			

Give official fall term enrollment figures (head count) for the current and preceding four academic years and undergraduate and graduate degrees conferred during each of those years. The "current" year means the academic year preceding the on-site visit.

FT—full-time
PT—part-time

Table D-2. Personnel

Aeronautics & Astronautics Engineering

Year[1]: 2018

	HEAD COUNT		FTE[2]
	FT	PT	
Administrative[2]	3	0	3.0
Faculty (tenure-track)[3]	15	0	15.0
Other Faculty (excluding TAs)	4	1	4.2
Student Teaching Assistants[4]	20	0	20.0
Technicians/Specialists	11	1	10.5
Office/Clerical Employees	1	3	4.5
Others[5] – Academic Advising	3	0	3.0

Report data for the program being evaluated.

1. Data on this table should be for the fall term immediately preceding the visit. Updated tables for the fall term when the ABET team is visiting are to be prepared and presented to the team when they arrive.

2. Persons holding joint administrative/faculty positions or other combined assignments should be allocated to each category according to the fraction of the appointment assigned to that category.

3. For faculty members, 1 FTE equals what your institution defines as a full-time load

4. For student teaching assistants, 1 FTE equals 20 hours per week of work (or service).

5. Specify any other category considered appropriate, or leave blank.

APPENDIX E – LIST OF VISITING COMMITTEE MEMBERS

The A&A Visiting Committee last met in November, 2016.

Members of the Visiting Committee are as follows*

Satya Atluri Texas Tech University, Department of Mechanical Engineering

Lars Andersen* Boeing, Vice President, Advanced 777 Product Development

Dana Andrews* Spaceflight Industries, Chief Technology Officer (Ret.)

Jason Andrews Spaceflight Industries, President

Siva Banda*, NAEError! Bookmark not defined. Air Force Research Laboratory, Chief S cientist Aerospace Systems Directorate

Paul Bevilaqua*, NAEError! Bookmark not defined. Lockheed Martin, Chief Scientist of S kunk Works (Ret.)

Suzanna Darcy-Hennemann* Boeing, Chief Pilot – Director, Flight Training (Ret.)

Bonnie Dunbar TEES Institute for Engineering Education and Innovation, Distinguished

Peretz Friedmann University of Michigan, Francois-Xavier Bagnoud Chair Professor, Dept. of Aerospace Engineering

Kourosh Hadi* Boeing, Director of Product Development

Laura McGill* Raytheon Missile Systems, Vice President – Engineering

Rob Meyerson* Blue Origin, President

Roger Myers* Aerojet Rocketdyne, Executive Director–Redmond Operations (Ret.)

Elaine Oran*, NAEError! Bookmark not defined. Glenn L. Martin Institute, Professor, Dept. o f Aerospace Engineering

Jaime Peraire* Massachusetts Institute of Technology, H. N. Slater Professor and Dept. Head, Aeronautics and Astronautics

Jerry Rising Lockheed Martin, Chief Engineer for Flight Sciences (Ret.)

Alton Romig*, **NAE**Error! Bookmark not defined. Executive Officer NAE – Lockheed Martin, V ice President Advanced Development Programs, Engineering and Advanced Systems (Ret.)

Wei Shyy* Hong Kong University of Science and Technology, Executive Vice President and Provost, Chair Professor of Mechanical and Aerospace Engineering

*Denotes members participating in the Nov 2016 Review
Error! Bookmark not defined. National Academy of Engineering

S. Rao Varanasi Boeing, Chief Engineer, In-service Structures and Aging Fleet (Ret.)
Vigor Yang*, NAEError! Bookmark not defined. Georgia Institute of Technology, Professor a nd William R. T. Oakes Professor and Chair, School of Aerospace Engineering

Submission Attesting to Compliance

Only the Dean or Dean's Delegate can electronically submit the Self-study Report.

ABET considers the on-line submission as equivalent to that of an electronic signature of compliance attesting to the fact that the program conducted an honest assessment of compliance and has provided a complete and accurate disclosure of timely information regarding compliance with ABET's *Criteria for Accrediting Engineering Programs* to include the General Criteria and any applicable Program Criteria, and the ABET *Accreditation Policy and Procedure Manual.*